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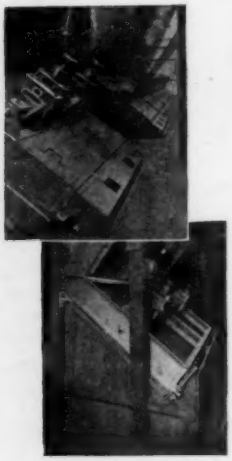

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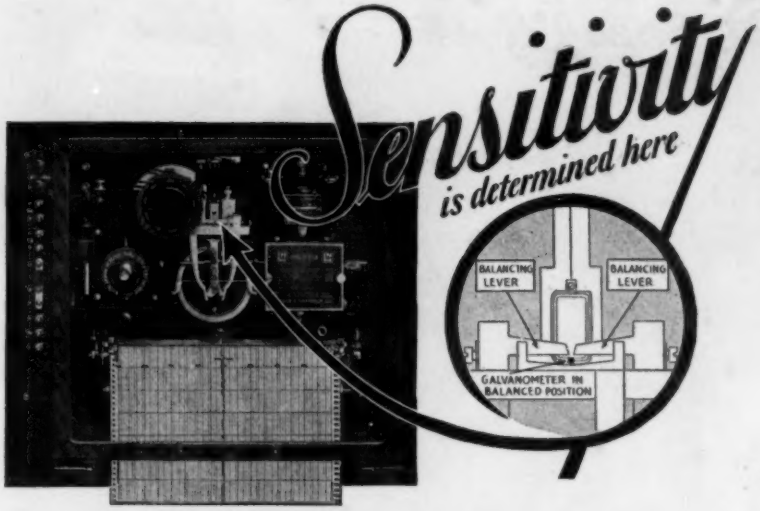

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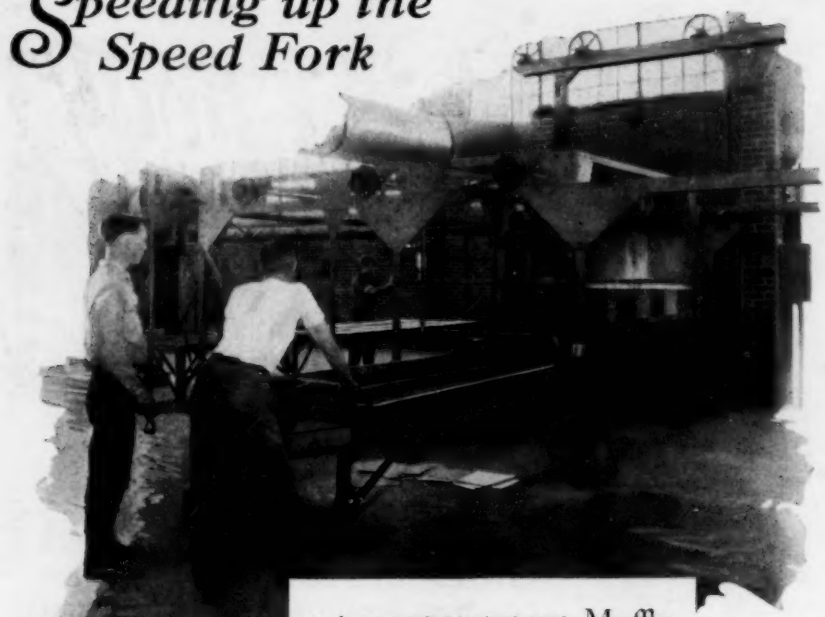

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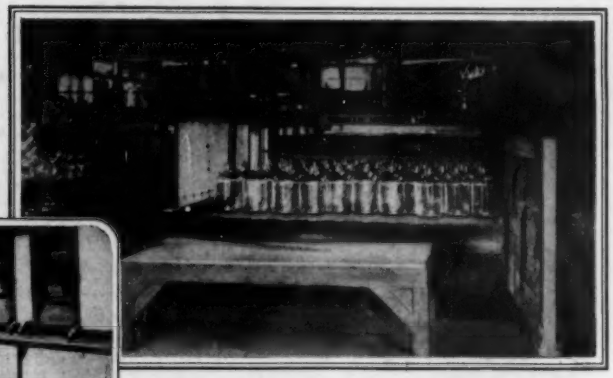

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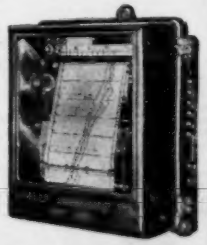

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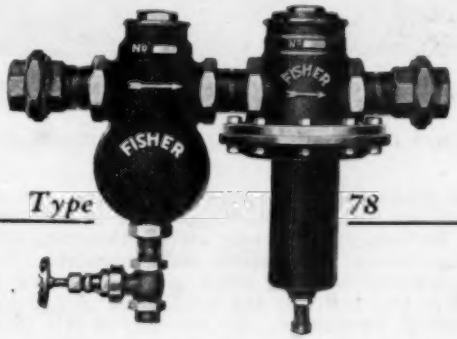

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THE DETERMINATION OF IRON IN GLASS SAND[1]

By G. E. F. Lundell[2] and H. B. Knowles[3]

ABSTRACT

Data are presented in tabular form showing the determination of iron in the Bureau of Standards Sample of Glass Sand, No. 81. The electrometric titration method, the H_2S reduction method, and the gravimetric method are described in detail.

A. General Considerations

One of the essentials in the manufacture of glass is a supply of good glass sand, and one of the requirements of such a sand is a minimum iron content. Methods for the determination of such small amounts of iron as are found in glass sand or glass have received careful attention, particularly by Ferguson[4] and by Ferguson and Hostetter.[5] The most commonly used procedures are the electrometric, the colorimetric, and the hydrogen-sulphide methods. In addition to these may be mentioned the sulphur-dioxide reduction method and the gravimetric method.

The standardization of the Bureau of Standards Sample of Glass Sand No. 81 afforded an excellent opportunity for testing the

TABLE I

DATA OBTAINED IN THE DETERMINATION OF IRON IN THE BUREAU OF STANDARDS SAMPLE OF GLASS SAND NO. 81.

Methods	Percentage of Fe_2O_3 found by the coöperating analysts and average differences from the most probable value 0.0724				Percentage of Fe_2O_3 found at Bur. of Stand.	Averages of final percentages obtained	
	First analysis	Average difference	Final analysis	Average difference		At Bur. of Stand.	By coöperating analysts
Electrometric	0.068		0.070				
	0.073		0.072		0.0714	0.072	0.072
	0.083	0.013	0.0726	0.001	0.0726		
	0.095		0.073				
	0.097						
Gravimetric	0.076	0.016	0.076	0.004	0.0720	0.072	0.076
	0.100				0.0724		
					0.0724		
					0.0724		
					0.0728		
Colorimetric	0.06	0.008	0.067	0.005	0.068	0.069	0.068
	0.065		0.068		0.069		
	0.067				0.070		
Reduction by hydrogen sulphide	0.066	0.012	0.077	0.006	0.0769	0.078	0.079
	0.097		0.079		0.0785		
	0.077		0.080				
Reduction by sulphur dioxide					0.0745	0.075	
					0.0749		

[1] Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Glass Division.) Received January 5, 1928.

[2] Chemist.

[3] Associate Chemist.

[4] J. B. Ferguson, *Ind. Eng. Chem.*, 9, 941 (1917).

[5] J. B. Ferguson and J. C. Hostetter, *Jour. Amer. Ceram. Soc.*, 2, 608 (1919).

performance of these methods in the same and in different hands. The results obtained by the coöperating analysts in their first analyses are given in Table I. These showed an average difference of over 0.01% from the most probable percentage of ferric oxide (0.072_4) and indicated that there was still ample room for improvement. The work described below shows that some of the methods require precautions that are not generally known and that some have limitations that should be taken into consideration. It therefore seems worth while to record the following observations.

B. Experimental

(a) Decomposition of the Sample

There is not much to say concerning the decomposition of the sample beyond what has already been pointed out by Ferguson,[4] who stressed the importance of decomposing by fusion any insoluble residue left after the initial attack on the sand by HF and H_2SO_4. An interesting observation made during the decomposition of Sample 81 was that the insoluble residue required fusion with Na_2CO_3 followed by fusion of the still insoluble residue with $K_2S_2O_7$. Fusion with the latter alone or with $K_2S_2O_7$ followed by Na_2CO_3 did not work, and the behavior was ascribed to the presence of zircon. This mineral resists fusion with $K_2S_2O_7$, but is decomposed by Na_2CO_3. The melt in the latter case is not entirely soluble in acids, but the insoluble matter is easily dissolved after fusing with $K_2S_2O_7$.

(b) Electrometric Titration Method

In the electrometric titration method commonly used, the iron is reduced by $SnCl_2$ and then reoxidized by electrometric titration with a standard solution of $K_2Cr_2O_7$.[6]

Such a method can yield excellent results when applied to pure solutions containing iron alone and corrected for a carefully determined blank. For example, the results of four successive determinations of Fe_2O_3 in aliquot portions of a solution of $FeCl_3$ were 0.00730, 0.00734, 0.00726, and 0.00726 or an average value of 0.00729 as against an actual content of 0.00730 gram. Four determinations in another solution, in which the blank was not determined and subtracted, gave an average value of 0.00744 as against an actual content of 0.00728 gram. The determination of the blank must be made in a small volume (25 to 50 ml.) after treating the reagents exactly as in the analysis and con-

[6] J. H. Hildebrand, *Jour. Amer. Chem. Soc.*, **35**, 871 (1913); J. B. Ferguson, *Jour. Ind. Eng. Chem.*, **9**, 941 (1917); J. B. Ferguson and J. C. Hostetter, *Jour. Amer. Ceram. Soc.*, **2**, 608 (1919); J. C. Hostetter and H. S. Roberts, *Jour. Amer. Chem. Soc.*, **41**, 1337 (1919); H. S. Roberts, *idem.*, **41**, 1358 (1919); *Jour. Amer. Ceram. Soc.*, **10**, 100 (1927). The apparatus needed is described by Roberts and can be purchased as a complete unit.

centrating the final solution if need be. In the present investigation the blank in the analysis of a 10-gram sample of sand corresponded to 0.006% of Fe_2O_3.

The solutions obtained in the analysis of glass sand contain, in particular, notable amounts of platinum which is introduced during the solution of the sample in HF and H_2SO_4 and the fusion with Na_2CO_3 or $K_2S_2O_7$, especially the latter. Platinum causes trouble in all methods in which $SnCl_2$ is used as a reducing agent for iron, and the electrometric method is no exception. If platinum is not removed it causes results that are erratic and, in otherwise careful work, high, as shown by the data in Table II.

TABLE II

EFFECT OF PLATINUM IN THE ELECTROMETRIC METHOD FOR THE DETERMINATION OF IRON

Fe_2O_3 taken mg	Platinum added mg	Fe_2O_3 indicated mg	Error represented in the analysis of a 10-g sample of sand per cent Fe_2O_3
7.28	1	7.58	+0.003
7.28	1	8.28	+0.01
7.28	3	7.86	+0.006
7.28	3	7.64	+0.004
7.28	3	9.66	+0.024
7.28	3	8.66	+0.014
7.28	5	8.88	+0.016
7.28	5	8.00	+0.007

The erratic behavior of the electrometric method when applied in the presence of platinum is also shown by the results obtained by C. A. Walworth, Chief Chemist of the Libby-Owens Sheet Glass Company, who obtained 0.101 and 0.090% of Fe_2O_3 in the analysis of Sample 81 when platinum was left in solution, and 0.073 and 0.073 after it was removed. Two other analysts obtained 0.097 and 0.095 when no regard was paid to platinum. The necessity for removing this element has not been mentioned in descriptions of electrotitration methods for the determination of iron in glass sand, feldspar, etc., and failure to remove it has no doubt been the cause of many discrepancies in analyses and of consequent disputes.

Platinum can be quite satisfactorily removed, after the sand is completely dissolved, by precipitating the iron by NH_4OH, filtering, and then dissolving the precipitate in HCl. Total removal can be made more certain by precipitating and digesting with H_2S in dilute H_2SO_4 solution, filtering, and washing with dilute H_2SO_4 (1:99) saturated with H_2S. When this method is used, care must afterward be taken to remove all H_2S by boiling and to oxidize polythionic acids by treating with a slight excess of $KMnO_4$ before reducing with $SnCl_2$.

(c) Colorimetric Method All of the common colorimetric methods for the determination of iron in glass sand are based on the color produced by thiocyanate ion in an acid solution in which

all of the iron in the sand is present in the trivalent condition. Methods of decomposing the sand, of separating iron from other substances, and of comparing the solution under test with that of the standard differ.

According to H. N. Stokes and J. R. Cain[7] the intensity of the color is extremely dependent upon the composition of the solution, and is by no means proportional to the concentration. The red color is due to the undissociated salt and to its double compounds. Many substances interfere in the reaction, notably fluorides, phosphates, arsenates and, to a less marked degree, sulphates. Moreover, a number of substances lessen the sensitiveness of the reaction. In short, the intensity of the color is so influenced by the nature and concentration of the substances present that unless the test solution and the standard solution with which it is compared have identical composition and concentration, results varying many hundred or even thousand per cent from the truth may be obtained. The preparation of a standard comparison solution having a composition exactly matching that of the unknown is manifestly a difficult matter and the separation of the iron from all of the other constituents in the sample under test requires more effort than the analyst is ordinarily willing to expend.

Careful determinations of iron in glass sand by the ordinary colorimetric methods must therefore normally give low results. This is shown in Table I and was also our experience, for in the analysis of Sample 81 we obtained average values of 0.069 by the procedure described by Scott[8], 0.068 by a procedure used by the Solvay Company[9]

[7] Bur. Stand., *Sci. Paper*, No. 53 (1907); *Jour. Amer. Chem. Soc.*, **29**, 409 (1907).

[8] Standard Methods of Chemical Analysis, 4th Ed., Vol. 1, p. 261. D. Van Nostrand Co., 1925. This method differs from usual procedures in that the color of the standard is matched by the dropwise addition of a solution of the sand as follows: 100 ml. of a very dilute standard, containing 10 ml. of H_2SO_4 and 0.00002 gram of Fe, is treated with 10 ml. of *N*NH_4CNS solution and the color is matched by diluting the solution of the sand to exactly 100 ml. and then adding the solution dropwise to a second cylinder containing 60 to 70 ml. of water, 10 ml. of the H_2SO_4, and 10 ml. of *N*NH_4CNS until the color matches that of the standard on dilution to 110 ml. No directions are given for the preparation of the solution as applied to sand.

[9] This method is as follows: Fuse 0.5 gram of sand with 5 grams of Na_2CO_3. Dissolve the melt in dilute HCl, evaporate the solution to dryness and remove silica in the usual fashion by double dehydration with HCl. Combine the silica recoveries, ignite, and volatilize with $HF-H_2SO_4$. Fuse the nonvolatile residue with 2 grams of Na_2CO_3, dissolve the melt in dilute HCl, and add the solution to the filtrate from the silica. Add 1 ml. of HNO_3, boil, and then add NH_4OH in excess. Boil for a few minutes, let the precipitate settle, filter and wash the precipitate five times with hot water. Dissolve the precipitate in 20 ml. of dilute HCl (1:1) and wash into a 100-ml. graduated flask. Dilute to the mark and mix. Pipette 25 ml. of this solution into a 50-ml. Nessler tube, add 5 ml. of KCNS solution (50 grams per liter) and dilute to the 50-ml. mark. To the second tube add 5 ml. of dilute HCl (1:1) and 5 ml. of KCNS solution and dilute nearly to the 50-ml. mark. Add dropwise and with stirring a standard iron solution (1 ml. = 0.0001 gram of Fe_2O_3) until the colors in the two tubes match. The result must be corrected by a blank test on all of the reagents used.

and 0.070 by a method described as an English fusion method,[10] as against the most probable value 0.0724. None of the determinations were made until sufficient work had been done on pure solutions of $FeCl_3$ to familiarize ourselves with the technic.

Our test showed that platinum also causes difficulties in the colorimetric method, in that it gives an "off" tint followed by a gradual bleaching of the color. It must therefore either be removed before the test is made, or else the test on reagents alone must be treated exactly as the sample and equal portions of both solutions used in the final comparison. Platinum can be removed well enough for all ordinary purposes by precipitating the iron with NH_4OH, filtering, and dissolving the precipitate in HCl. Such treatment is all the more desirable in that it eliminates H_2SO_4 and the alkaline earths, all of which affect the final color.

(d) H_2S Reduction Method

In the hydrogen-sulphide method, iron is reduced by H_2S in a dilute solution of H_2SO_4, the solution is boiled and the excess of gas is driven out by passing a stream of CO_2 through the solution. The iron is then reoxidized by titration with a standard solution of $KMnO_4$.

The treatment with H_2S yields small amounts of polythionic acids, and these cause high results for iron in any careful analysis by the method.[11] For example in our analyses of Sample 81 the average percentage of Fe_2O_3 found was 0.0785 by W. F. Hillebrand's method,[12] and

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[10] Private communication from the Solvay Company. This method is as follows: Transfer 0.5 gram of the finely floured sample to a freshly cleaned platinum dish of about 3 inches diameter. Thoroughly wet with 5 ml. of dilute H_2SO_4 (1:2) and tare the dish and contents on a rough balance. Place a 10-gram weight on the weight pan and counter-balance by pouring pure HF into the dish. Heat the dish over a low flame until the H_2SO_4 fumes strongly. Cover, dilute slightly with H_2O, and weigh in 5 ml. more of HF. Repeat the evaporation, this time to dryness. Heat to dull red, cool, add 0.5 g. of Na_2CO_3 and fuse for 1 to 2 minutes over a free flame, taking care to fuse all of the residue. Cool, cover and dissolve in HCl and H_2O. Transfer the solution to a 250-ml. flask, add a few drops of bromine water, dilute to the mark and mix. Prepare a standard solution of iron containing 0.000005 g. of Fe_2O_3 per ml.; the solution should be slightly acid with HCl and contain a few drops of HNO_3 or Br_2 per liter. Transfer 25 ml. of the unknown to a Nessler tube, add 2 drops of HNO_3 and 5 ml. of a 10% KCNS solution. To a second tube add 25 ml. of H_2O, 2 to 3 drops of HCl and 2 drops of HNO_3 and match the color in the first tube by dropwise addition of the standard. Repeat the test, this time adding the required amount of standard to the second tube, then the HNO_3 and finally the KCNS solution, taking care to add the latter to each tube at approximately the same time, and in the same amount. Correct any slight difference in color by the addition of the iron standard. Correction must be made for iron in the reagents. This is determined by proceeding as in the analysis, but keeping the final solution at 25 ml. instead of taking an aliquot.

[11] G. E. F. Lundell and H. B. Knowles, *Jour. Amer. Chem. Soc.*, **43**, 1560 (1921).

[12] The "Analysis of Silicate and Carbonate Rocks," U. S. Geol. Survey, *Bull.*, No. 700, pp. 119–120.

0.0769 by the authors' modification of that method,[11] as against the most probable value, 0.0724.

The sulphur-dioxide reduction method is satisfactory when applied to solutions containing iron alone, but gives high results in the presence of platinum. Unfortunately it is by no means certain that H_2S completely removes the platinum introduced during the decomposition of the sand. This is shown by the results 0.0745 and 0.0749 which we obtained in very careful analyses by the method.

(e) The Gravimetric Method

The most desirable gravimetric method[13] for the determination of iron in glass sand is that in which the iron is separated from aluminum, titanium, zirconium, and the like, by precipitation as the sulphide in an ammoniacal solution containing tartrate, and with final precipitation by NH_4OH.

In this method it is desirable to start with a 25-gram sample and it is necessary to remove the hydrogen sulphide group, to make sure that

[13] The gravimetric method used is as follows: Transfer 25 grams of the dried sample to a liter platinum dish, moisten with water and add 200 ml. of HF and 10 ml. of dilute H_2SO_4 (1:1). Evaporate to fumes of H_2SO_4, cool, rinse the walls of the dish with water, and again evaporate to fumes of H_2SO_4. Treat the contents of the dish with 100 ml. of water, heat to boiling, filter through a No. 42 Whatman paper, wash with hot water, and reserve the filtrate (A). Ignite the residue in the paper, fuse with a small amount of Na_2CO_3, and dissolve the melt in dilute sulphuric acid (1:5). Filter, wash the residue, and combine the filtrate with the original filtrate (A). Again ignite the paper and insoluble matter. Fuse with a minimum quantity of $K_2S_2O_7$, dissolve in dilute H_2SO_4 (1:5) and combine the solution with the reserved filtrate (A). Neutralize the solution with NaOH, dilute to 250 ml. and then add 2 to 3 ml. of H_2SO_4. Thoroughly saturate the solution with H_2S, and digest, preferably overnight. Filter and wash with diluted H_2SO_4 (1:99), saturated with H_2S. To the filtrate add 10 grams of tartaric acid and again saturate with H_2S. Slowly add dilute NH_4OH (1:2) until the solution is ammoniacal and pass in H_2S for 10 to 15 minutes. Allow the iron sulphide to settle, filter through a paper of close texture and wash thoroughly with a 1% solution of ammonium tartrate-ammonium sulphide, always keeping the funnel filled. Place the filter and its contents in the beaker in which the precipitation was made and treat with 25 ml. of HNO_3 (specific gravity 1.42) and 5 ml. of H_2SO_4 (specific gravity 1.84). Cover, and cautiously heat until fumes of H_2SO_4 are evolved. If the solution still contains organic matter, cautiously add HNO_3 (specific gravity 1.42) dropwise and continue the treatment until the solution clears and all organic matter is destroyed. To make sure of the separation of the titanium, etc., cool, rinse the cover glass, dilute to 200 ml. with H_2O and to the clear solution add 5 g. of tartaric acid. Again thoroughly saturate with H_2S, make ammoniacal, digest, filter, wash the precipitate, and dissolve it in H_2SO_4 and HNO_3 as before. Cool the sulphuric acid solution, dilute to 150 ml. with H_2O, heat to boiling and precipitate the iron with NH_4OH. Filter, wash the precipitate a few times with a hot 2% solution of NH_4NO_3 and ignite the precipitate and paper. Cool, treat with a few drops of dilute H_2SO_4 and a few ml. of HF, and evaporate to dryness. Cautiously expel the H_2SO_4 and ignite to constant weight at approximately 1000°C under good oxidizing conditions. The weight of oxide found must be corrected for the oxide found in two or three runs on the reagents carried through all operations.

enough tartrate is present, and to free the ignited oxide from silica obtained from the NH_4OH and by attack of the glass ware. By the use of this method at the Bureau of Standards 0.0720, 0.0728, 0.0724, 0.0724, and 0.0724 were obtained in five successive runs. When properly carried out, this method should give results that are accurate to $\pm 0.0005\%$. If it is not carefully carried out the results are apt to run high.

Summary

Of the methods in common use for the determination of iron in glass sand the colorimetric method normally gives low and the others high results. Correct results can be obtained by proper modifications of the colorimetric method, but at an immoderate expenditure of effort. High results are unavoidable in any modifications of the hydrogen sulphide reduction method and are difficult to avoid in the corresponding sulphur dioxide method. Both the gravimetric (precipitation as sulphide and conversion to oxide) and electrometric methods can give satisfactory results. The former is the most accurate of all the methods but requires numerous precautions and very careful manipulation. The latter is rapid and is entirely satisfactory, provided platinum is excluded and the blank correction is properly determined.

Careful determinations of iron in a sand containing 0.07% Fe_2O_3 by the methods that have been described are subject to errors at least as large as the following:

Gravimetric	± 0.0005
Electrometric	± 0.001
Hydrogen sulphide reduction	$+0.006$
Sulphur dioxide reduction	$+0.003$
Colorimetric	-0.004

An agreement to 0.002% of Fe_2O_3 is all that can be expected when a sample of sand containing 0.07% of Fe_2O_3 is analyzed by two analysts using the same method. If the analysts use different methods, their results may differ by as much as 0.01% unless each analyst has corrected his result according to the limitations of the method used.

BUREAU OF STANDARDS
WASHINGTON, D. C.

WHITE ENAMEL AND GRAY HAIR[1]

By R. D. Cooke

ABSTRACT

The causes of opacity are discussed and examples listed. The chief cause is the great difference in indices of refraction of materials intimately mixed. The explanation of white enamels is given, discussing the effect of thickness on the reflection factor, and the intrinsic whiteness of enamels.

The title of this paper is not an attempt at facetiousness. There are apologies, however, due to W. D. Bancroft, who addressed the American Chemical Society a few years ago on the subject "Blue Sky and Blue Feathers."

There have been attempts from time to time to stimulate discussion among enamelers on the subject of "opacity," but most of these have been abortive because at every attempt to get down to first principles it was found that there were no generally recognized first principles. There were only vague ideas as to what were the exact scientific reasons for a white enamel being white, and there was even a lack of definite terms with which to define "whiteness." This state of affairs was unsatisfactory and it is the purpose of this paper to attempt to bring some order out of the existing scattered ideas on the subject.

It is generally agreed that a white enamel is obtained by using a frit as white as possible and adding a white pigment to it in the mill. It remains to be determined what a pigment is and whether it is legitimate to refer to white coloring matters as pigments. We think of a pigment as a finely-divided opaque substance capable of reflecting light of certain colors. To apply this meaning to a white material we shall have to modify the above to the extent that the material reflects light of all colors of the spectrum equally. True white pigments are in fact extremely rare in nature. It may very well be questioned whether, indeed, there is any such thing as a white pigment, and this without quibbling over the definition of the term.

Examples of Opacity

In a list of a few of the whitest things known, there are the new fallen snow and the petals of the Easter lily; another is the cloud illuminated by the sun, and still another is any kind of clean foam. Of less perfect whiteness, but included here for the purpose of making the illustration complete are milk, oil-water emulsion, and white enamel. These things, so different in most ways, have several points in common. None is a uniform, homogeneous body but a mixture of two or more things of widely different physical character. Not as obvious, but none the less

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J. February 1928. (Enamel Division.) Received December 9, 1927.

true, these substances which make up the mixture are in each case transparent substances of widely different indices of refraction. In the case of snow the mixture is of ice crystals and air, both transparent. In the lily petals it is said that the whiteness is due to the dispersion of air cells in the transparent substance of the petal. Incidentally gray or white hair results from the same thing and is not the result of loss of dark pigment. The cloud is a dispersion of fine drops of water in air, while foam is the reverse condition, a dispersion of air particles in a liquid. In the case of milk there is a solid, casein, suspended in a liquid, and in the oil-water emulsion there is an intimate mixture of two transparent liquids. The last example, white enamel, is a suspension of particles of one solid within another. It may not be so apparent that tin oxide or some of the other opacifiers are in themselves transparent, but if a sample of raw tin oxide be well dispersed on a slide and be examined under the microscope with fairly high power and dark ground illumination, all doubt will be dispelled.

Opacity Due to Difference in Indices of Refraction

The conclusion from these and many other examples is that white substances are never homogeneous but are intimate mixtures of two or more transparent materials of widely different indices of refraction. A simple experiment which anyone can perform further confirms this. A mixture of water ($n=1.33$) and turpentine ($n=1.472$) shaken up thoroughly is quite white. A mixture of turpentine, however, with glycerine ($n=1.472$) shaken up must be examined closely to detect the fact that they are in reality dispersed in each other and not dissolved. The intimate mixture has almost the effect of a clear liquid due to the fact that their indices of refraction are so nearly identical. On standing they separate out into two layers as the turpentine and water.

A brief review of elementary optics will explain why stress is placed on the index of refraction. When light passes at an angle through the boundary between two substances of different indices of refraction, it always suffers a change of direction, the greater the difference in index the greater the change. When the two substances are finely divided and intimately mixed the changes in direction in the light rays are very numerous, the light penetrates only a short distance into the mixture, and is soon returned to the surrounding air as diffusely reflected light. The greater the differences in indices of refraction, the more abrupt turn will the path of each ray make and the sooner will it find its way back to the air. Since it has suffered fewer internal reflections, there will also have been less absorption of energy and consequently more of the initial light will have returned to the air as reflected light.

Definition of Whiteness

Reflection Factor This gives a basis for a definition of whiteness as the ratio between the total light energy received on a surface and the total light energy reflected from the surface. The ratio expressed in per cent is called the reflection factor. To be strictly correct for a true white surface it should be added that the reflection factor should have the same value when taken on different parts of the spectrum.

Tones of White Nothing has been said thus far about tones of white such as cream-white, blue-white, and pink-white. If both transparent substances making up this mixed system are colorless there will be no absorption of certain wave-lengths in excess of others and no deviation from pure white in the final result. If one of the components, however, absorbs certain colors ever so slightly the effect will be multiplied at each internal reflection and ultimately will be very much exaggerated; the effect will be a noticeable tint. If it is blue it means that yellow is being absorbed. If then, as is sometimes done, a yellow substance is added to absorb the excess blue, a white is achieved; but since both blue and yellow are being absorbed, energy is lost and the reflection efficiency of the surface is impaired.

Explanation of White Enamels

These considerations thus far apply with equal truth to any white surface. It is now possible to apply them specifically to enamels. White frit is considered first and because of its whiteness must itself be a two-component system. There has been much discussion in the past as to whether the cloudiness or opalescence produced by fluorine compounds is due to dispersed gas bubbles or to dispersed glass of a different kind from the surrounding mass. Very recent studies[2] by means of X-ray spectrograms have shown that opaque frits contain crystals of fluorine compounds such as sodium fluoride and calcium fluoride. These facts coupled with the fact that fluorine compounds are notably low in index of refraction show why white frits are white. The ordinary silicate glasses such as may be encountered in enamel batches have indices ranging from 1.50 to 1.55, while the index of calcium fluoride is only 1.43 and sodium fluoride still lower. The final step in making enamels white is the addition of opacifier to the mill. The materials commonly used have indices of refraction near 2.00. A typical white enamel in its final state thus shows a glassy mass of medium index having suspended in it very fine particles of substances of lower and higher indices. Since lead glasses have higher indices of

[2] G. Agde and H. F. Krause, *Z. Angew. Chem.* **40**, 886 (1927).

refraction than those not containing lead, it might be predicted that lead enamels would be made whiter by fluorine compounds and would not be whitened as much by tin oxide as compared with leadless enamels. It would be interesting to have this verified experimentally from the present point of view.

Effect of Thickness on Reflection Factor

With this means for expressing whiteness of enamels quantitatively, namely the percentage of incident light which is reflected, or "reflection factor," it is possible to conduct some controlled experiments showing the effects of certain conditions on the whiteness of enamels. A series of such experiments was made with the idea of relating the thickness of enamel and the percentage of opacifier with the reflection factor. A standard white enamel was milled with 0, 4, 8, 12, and 16% of tin oxide. Some sample plates were sprayed with each of these enamels in various thicknesses, attempting to go somewhat beyond the commercial range in both directions. The heavier samples were coated twice. The reflection factor of each sample was measured approximately with the E.T.L. reflection gage. The thicknesses were then measured by breaking off chips of the enamel and standing a cleanly broken chip on edge under a micrometer microscope. The thicknesses are expressed in millimeters. There resulted the data for a curve thickness *vs.* reflection factor, for each enamel.

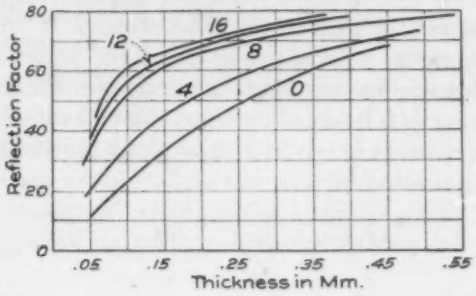

FIG. 1.

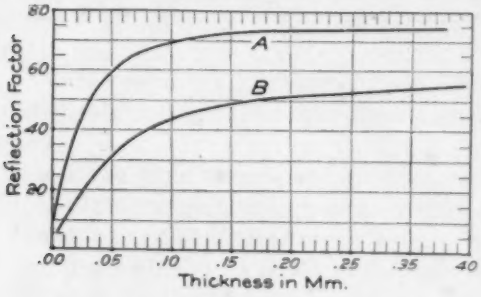

FIG. 2.

Intrinsic Whiteness of Enamels

These curves for each of the different percentages of tin oxide are shown in Fig. 1. The particular application of a curve of this kind is in determining what may be called the intrinsic whiteness of any enamel. If the reflection factor and the thickness of an enamel under investigation are determined and the resulting point plotted on a sheet having on it the curve for a standard enamel, the point will be either above, on, or below the curve. The enamel in question is then either higher, equal to, or lower in intrinsic

whiteness than the standard regardless of what the thickness of application may have been.

Figure 2, Curve *A* is a curve of the same kind as discussed above but taken from a varying number of thicknesses of very thin tissue paper laid over a dead black background. It is apparent that the form of the curve is very similar to the enamel curve. Curve *B* was taken in exactly the same way except that the tissue paper was oiled. The whole curve is lower showing that the intrinsic whiteness was less. Of course the reason for this is that the index of refraction of paper fibers and the oil are more nearly the same than the indices of the paper fibers and the intermingling air.

BENJAMIN ELECTRIC MFG. COMPANY
DES PLAINES, ILLINOIS

THE DEVELOPMENT OF A KILN FOR FIRING SEWER PIPE[1]

By E. F. Clemens

ABSTRACT

Full description is given of a kiln for firing sewer pipe, with dimensions and innovations which have proven best. The use of smaller fire boxes tends to prevent overfiring, to give hotter and more complete combustion, and to prevent roughness.

Since 1923 this company has built seventeen kilns of various sizes and types. From what has been learned in the construction and operation of these kilns, from experiments in firing pipe of various sizes in various types of kilns, and from research work of the Clay Products Association, a type of kiln has been standardized which seems to give the best results in firing sewer pipe by natural draft under particular conditions.

No two manufacturers of clay products have exactly the same conditions to meet in firing due to variation in raw materials and fuel. The type of kiln which is giving the best results at this plant might fail at some other plant.

Objective and Conditions

The objectives sought were (1) the highest percentage of No. 1 ware, (2) low fuel consumption, (3) simplicity and ease of control, and (4) low kiln upkeep and long life of kiln. Quality of product is placed first for the reason that this firm has always stressed it in sales appeal and because a high percentage of No. 1 ware means a low production cost.

Sewer pipe ranging from 4-inch standard to 30-inch double strength together with the usual companion lines of vitrified clay products is fired.

The clay used is a mixture of Ohio River fire clay and shale. It has excellent drying qualities, but gives a great deal of trouble from black-coring.

The firing time ranges from four to eight days, depending upon the size of the ware with an actual average for all kilns of 130 hours.

Finishing temperatures range from cone 3 in the bottom to cone 7 in the top with cone 4 down in the trial box, 3 feet above the floor.

The fire clay used contains an unusually high percentage of coarse iron minerals which would cause considerable roughness under reducing conditions. Excess air must be used throughout the progress of the firing to prevent roughness and black-coring. Under oxidizing conditions the clay takes a bright glaze with a clear buff body.

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[1]Presented at the Annual Meeting of the American Ceramic Society, Atlantic City, N. J., February 1928. (Heavy Clay Products Division.) Received January 3, 1928.

The coal used is Southern Indiana (2 by 4 egg coal) of the following analysis: moisture 1.33, volatile matter 43.51, fixed carbon 48.13, ash 7.03, sulphur 2.11, B.t.u. (dry) 13,214 It is rather smoky and forms clinkers easily. Handling this coal to prevent roughness and give a bright clear glaze has been rather a problem but it is the only coal available for use from the standpoint of cost.

The Kiln

Figure 1 shows the kiln in detail and gives the essential dimensions. It also shows the method of banding. In this particular case, the kiln happens to be a 30-foot kiln, twelve feet of which are now being constructed. The principles of construction and general proportions would be the same for any size kiln.

Stack One stack serves four kilns. It is 52 feet high, and while this is rather high for fuel economy, the effect of the height after watersmoking is completed, is overcome by cutting the draft as much as possible This extra height gives the necessary draft in all kinds of weather, speeds up watersmoking, and gives the fireman a positive control of draft conditions at all times.

The tunnel leading to the stack is built of fire brick; it is 9 inches thick with a 2-inch paving course in the floor. It is 28 inches wide and 26 inches high at the edges, and 36 inches high at the center of the arch. These are inside dimensions. It leads from the center well-hole on a slight upgrade to the stack.

Kiln Walls The walls of the kiln, including the foundation are 31 inches thick, 22 inches of hard, common brick, and a 9-inch refractory lining from 19 inches below the surface of the floor to the crown. The wall of the kiln is straight, for experience has proved that the upkeep on this is considerably less than on the hub type of kiln.

Flues The hub and spoke type of bottom with auxiliary flues of brick is used. This type of floor and flue construction has been tested thoroughly at this plant against the spider type of flue system using brick flues, and the hub and spoke type using unglazed sewer pipe for flues. We are convinced of the superiority of this construction from the standpoint of uniform heat distribution and low upkeep cost.

The brick flues have $4\frac{1}{2}$-inch firebrick walls and the two top courses are corbelled to permit the use of reclaimed 12-inch floor brick for the top. The inside dimensions of the flues are 10 inches wide by $18\frac{1}{2}$ inches high. There are three sets of openings into these flues. The first is $4\frac{1}{2}$ by $4\frac{1}{2}$ inches square and is located 6 feet from the center of the kiln. The second is $4\frac{1}{2}$ by 9 inches and is located 10 feet from the center of the kiln. The third is a semicircular receiver extending the full width of the opening between the bags made of fire brick with walls $13\frac{1}{2}$

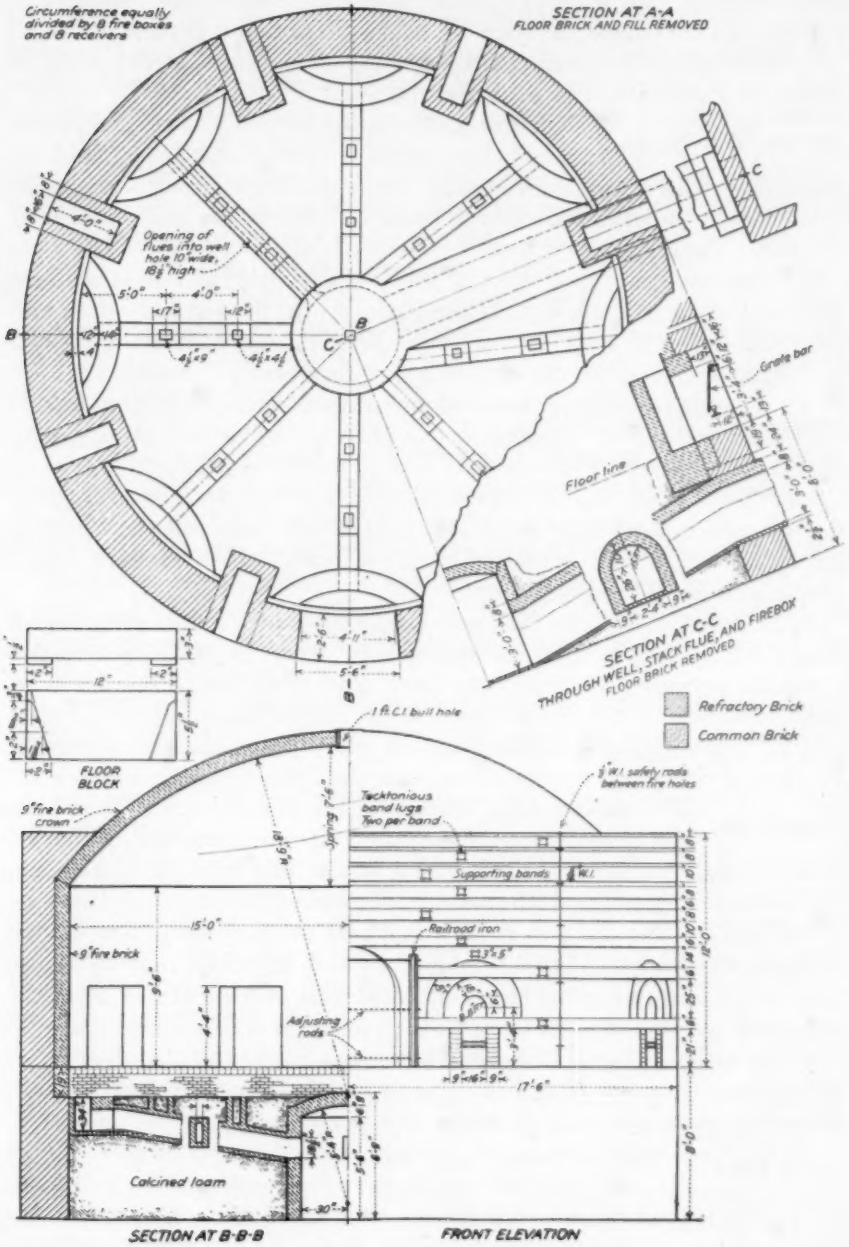
Circumference equally divided by 8 fire boxes and 8 receivers
SECTION AT A-A
FLOOR BRICK AND FILL REMOVED
Opening of flues into well hole 10" wide, 18½" high
Grate bar
Floor line
SECTION AT C-C
THROUGH WELL, STACK FLUE, AND FIREBOX
FLOOR BRICK REMOVED
Refractory Brick
Common Brick
FLOOR BLOCK
1 ft. C.I. built hole
9" fire brick crown
Tecktonious band lugs Two per band
¾" W.I. safety rods between fire holes
Supporting bands
W.I.
Railroad iron
9" fire brick
Adjusting rods
Calcined loam
SECTION AT B-B-B
FRONT ELEVATION

FIG. 1.

inches thick. This type of receiver is easily cleaned, provides plenty of draft in the pockets between the bags, and does not get out of shape. A glimpse at the blueprint will show the advantages of this type of flue from a standpoint of heat distribution.

Center Well-Hole The center well-hole into which the auxiliary flues lead is 5 feet inside diameter and 6 feet high at the center There is a 4-inch opening at the top of the crown of this well-hole so as to provide a certain amount of draft in the exact center of the kiln. The height of 6 feet permits the stack flue to leave the well-hole below the bottom of the auxiliary flues so that the pull is uniform from all portions of the kiln. The openings into the auxiliary flues and well-hole from the floor give a better draft during watersmoking and oxidation in the center of the kiln where most draft is needed

Floor There is nothing unusual about the floor construction. It consists of six courses of hard fireclay brick laid up dry with checkered openings in the middle four courses and a standard type of 12-inch floor brick above. There is probably some room for improvement in the type of floor brick and at this time experiments are being conducted on a little different type of brick which gives a larger percentage of opening in the floor.

After drawing of a kiln the floors are painted with a thin slip made of mason's lime and water. By this means the average life of the kiln floors has increased from one year and three months to a minumum of two years. After the floors are removed, the floor brick are cleaned and 75% are good for at least two or more years additional service. The use of reclaimed floor brick has cut the upkeep costs considerably.

Fire Boxes The most radical feature of the kilns is the width of the fire boxes. Several years ago our fire boxes were all either 22 or 24 inches wide. Eight boxes on a 30-foot kiln were used, nine on a 32-foot kiln, and ten on a 36-foot kiln. It was certain that the large fire boxes were costing the firm money and were not necessary; a reduction in width was started. The first reduction was to 20 inches, then 18 inches, and, when it was ascertained that there was still plenty of heat, the reduction was made to 16 inches which is the firm's standard size

These little fire boxes have been so successful that all of the fire boxes have been cut down to a size ranging from 16 to 18 inches in width, depending upon the way in which the brick work out.

Grate Bars An inclined grate furnace is used constructed of 2- by $^3/_4$-inch bars usually bought from some junk dealer and cut to the desired length. A grateless firebrick furnace with two arches was tried out, but due to the smoky nature of the coal enough air could not be gotten through the fuel bed and the glaze was dulled considerably. Flat grates were tried but very poor results were ob-

tained. The inclined grate bars together with the use of egg coal allow the entry of a certain amount of air through the fuel bed. An auxiliary opening 3 by 5 inches is provided through the wall above the furnace arch to permit excess air to be admitted all through the firing. This opening is not c'osed at all during the firing except in unusual cases and then only by the head fireman. The excess air admitted through this opening helps to produce a bright clear glaze. Building an opening to bypass the air so that it would be thoroughly preheated, was attempted. but the expense of upkeep made the plan inadvisable.

Bag Walls There is nothing radical about the design of the bag walls which, due to the narrow furnace, gives a little extra room between the bags for a few more small pipe. The bag walls are 4 feet 4 inches high, which size gives the best results with the method of setting in use.

Crown The spring of the crown begins at a point 9 feet 6 inches above the floor level and the crown has a spring of 7 feet 6 inches or one-fourth of the diameter. The large-sized ware is set to a height of 9 or 10 feet by means of an electric crane.

The outside walls are carried to a height of 12 feet above the ground.

The crown is constructed of the best grade of 9-inch fire brick. It is insulated by a covering of 6- to 12-inch layer of cinders. A small fuel saving is obtained with this over a crown which is not insulated, or which is plaited with old fire brick.

A retaining wall constructed of used fire brick is built to a height of about 15 inches to prevent the insulating material from being washed off the kiln

Temperatures are recorded by means of a standard type of Noble metal thermocouple.

Bands Three 6- by $^5/_{16}$-inch wrought iron bands are used to brace to the top of the door, then two 8-inch, one 10-inch and two 8- by $^5/_{16}$-inch bands are used to the top of the kiln. Two pairs of lugs and fasteners are used for each band. Wrought iron bands are used although higher in price than stee' for the reason that they have given much better service.

Results Obtained

Two kilns of this type have been in use now for about four months with pleasing results. The effect of the narrow fire boxes has been to prevent overfiring, to give a hotter and more complete combustion in the fire boxes, and to prevent roughness. The kiln gives as near smokeless combustion as is possible with natural draft In firing, the fireman uses the minimum amount of draft possible to maintain his predetermined firing schedule and in this way somewhat reduces his coal consumption.

Ware Quality On the first four firings, three of which were made on 27-inch double strength pipe and one on 24-inch double strength pipe, an increase was obtained in the percentage of No. 1 ware produced. The figures for the first four firings together with the average of all kilns for the same period are as follows:

	New Kiln (per cent)	Average of all kilns
No. 1 ware	93.15	88.52
No. 2 ware	3.28	6.63
No good	3.57	4.85

The pipe is graded very closely in the kilns and the 24- and 27-inch double-strength pipe in the foregoing data were shipped on a sewer job where they were subjected to very rigid inspection. Only five seconds were found in the total of the 24- or 27-inch pipe in the first four firings and there were no "no goods" at all in these sizes.

The Glaze The glaze obtained in this type of kiln is the finest that has ever been secured here. The ware always takes a good thick glaze but there has been some trouble from roughness This has been entirely overcome in the new kilns and a bright thick glaze with no roughness is obtained.

Fuel Economy Tests on the fuel consumption on this kiln show that it uses about 14% less fuel than the 32-foot kilns with 22-inch fire boxes average, on 27-inch double strength pipe. It is certain, however, that the small fire box offers the best means of reducing fuel consumption on the kilns.

Control From the standpoint of ease of control, this kiln is almost ideal. The small fire boxes prevent overfiring; the high draft in the stack and the use of the damper give control of the kiln under all weather conditions, and the openings over the fire boxes guarantee the admission of excess air from beginning to end of the firing.

Upkeep This type of kiln constructed of good fire brick should give long life with a minimum of upkeep. The heavy walls and the method of banding prevent the walls from kicking out of shape. The fire box and arch can be renewed without tearing out the walls. The brick flues and tunnels have a much longer life than those constructed of unglazed sewer pipe.

Acknowledgment George H. Duncombe, Jr., and R. E. Arnold, in charge of the research work of the Clay Products Association at Mellon Institute, have greatly assisted the firm in the development of this type of kiln. The experiments which have been undertaken have been prompted in large measure by their suggestions.

CANNELTON SEWER PIPE COMPANY
CANNELTON, IND.

EXPERIMENTS WITH STOKER FIRING[1]

By E. F. Theobald

ABSTRACT

The use of stokers on a downdraft kiln is discussed. Results of several firings are given, changes being made to correct defects observed. Difficulties encountered and advantages noted are listed.

Introduction

The Problem In applying stokers to a rectangular downdraft kiln there are quite a few problems which must be solved before the stokers can be made to operate successfully. At first it was calculated that one large stoker built on the end of a 90-foot kiln would be sufficient and the next suggestion made was to put two 72-inch stokers on the kiln, one at each diagonal corner. Even this seemed too small and it was decided to put three 54-inch stokers on one side of the kiln. There was a discussion at the time as to whether the stokers should be located two on one side and one on the opposite side or whether to place them all on one side.

The Kiln The kiln used was a rectangular downdraft kiln 88 feet long and 18 feet wide inside dimensions, with three large stacks on one side. The stacks were double, serving two kilns and took up a great deal of room. For this reason and also because a stoker placed in the center would interfere with the flue to the center stack, it was decided to put all the stokers on one side of the kiln, opposite the stacks.

The kiln when hand-fired contained 24 furnaces, 12 on a side, each 30 by 40 inches or a total of 200 square feet of grate area; the figures showed that the maximum coal consumption would be about one ton per hour or possibly a little more.

The Stokers The grates on the stoker were 54 inches wide and 6 feet long set at an angle of about 36°; three 54-inch stokers, therefore, would give a grate area of 81 square feet. By burning 25 pounds of coal per square foot per hour, which is done in boiler practice, it was assumed that a ton of coal per hour could be burned, or a little more if necessary.

Each stoker was a complete furnace built entirely outside the kiln and no part of the grates or any working mechanism extended inside the kiln wall. This was a good feature because it eliminated any warping or breaking due to a part working in an excessive heat.

The furnace extended about $6^1/_2$ feet outside of the kiln wall and was built with a 9-inch firebrick lining and 9 inches of shale brick, the crown being insulated with 4 inches of Sil-O-Cel powder.

Each stoker was equipped with a 5 horse-power motor speed reducer, and an 18-inch Sirocco fan. The normal speed of the motor and fan

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Heavy Clay Products Division.) Received December 12, 1927.

was 1200 r.p.m., which could be increased to 1700 by the use of a rheostat. The fan was capable of supplying 3500 cubic feet of air per minute at atmospheric temperature which was used as a forced draft under the grates and also supplied any excess air which might be needed over the top of the grates.

The hopper was large enough to hold 600 pounds of coal and directly under this was a reciprocating table which fed the coal onto the grates which also had a reciprocating motion. The feed was controlled by a hand wheel which increased or decreased the length of stroke of the table. There was also a 3-step cone pulley which would vary the speed; in addition, the speed of the motor could be varied from 1200 to 1700 r.p.m.

Operating Experience on First Firing

In the first firing the watersmoking period was over in 38 hours, which was a few hours less than it takes on a hand-fired kiln. After the watersmoking period some difficulty was experienced in raising the heat in the kiln due to inexperience in handling the stokers. The trouble was that the blast was too heavy and was blowing holes in the fires on the grates. This difficulty was only temporary and was soon corrected. After reaching a temperature of 1850°F and above, the main trouble was with the formation of clinkers. In order to maintain a high enough temperature it was necessary to carry a very heavy fuel bed which prevented the coal from being completely burned by the time it reached the bottom dumping grates. These grates were intended as a reservoir for ashes but in this case were being used as available grate area. This resulted in the formation of large clinkers, some of them so large that it was almost impossible to get them out of the furnace. The stokers were being cleaned every six hours but in order to prevent the formation of such large clinkers it was necessary to clean them every three hours, which made it hard to maintain the proper temperature.

Length of Firing

By this time it seemed evident that the stokers were too small for the job and that more grate area was needed. The first stoker firing required 12 days and 17 hours; this included about one day in which the temperature was held down in order to dry out the new brick work in the stokers and prevent cracking.

The Brick

The brick which were fired in this kiln were of a very rich red color due to oxidizing conditions throughout the firing except in the watersmoking period when smoke could be seen coming from the stacks. There was a heavy deposit of ash on the taper and top course of brick in the kiln. This was due to forced draft and slack coal. The kiln had been set with 3-inch straight wire-cut block and the rattler test was equally as good as on the hand-fired kilns but the cull percentage was higher.

Changes Made in Stoker It was thought that the reason that the progress of heating the kiln was so slow was because there was not enough air in the kiln to carry the heat to the bottom; therefore before the second firing, the size of the pipe which carried air over the top of the fire was increased from 5 inches to 8 inches. Several other changes were made, such as increasing the size of the opening for the removal of clinkers, deepening the ash pits, and building larger bag walls to permit a freer passage of the gases into the kiln.

Second Firing With these changes a second firing was started. This time no forced draft was used, the kiln being watersmoked with natural draft and requiring 53 hours. This eliminated the heavy deposit of ash which was found on the brick in the first firing. Forced draft was used later. This firing required 10 days and it was now evident that more stokers would be required to fire the kiln off in the average time.

Additional Stokers Two more stokers were built on the opposite side of the kiln. But instead of 54-inch stokers, the size of the three original stokers, 36-inch stokers were decided upon. There were two reasons for this. One was that the investment in five 54-inch stokers was considered too large to give an adequate return and the second reason was on account of difficulties of construction. A 36-inch stoker could be built without tearing out any of the buckstays of the kiln.

Third Firing The first firing with the five stokers was, of course, more successful than the others with only three stokers. It was possible to raise the heat faster after the watersmoking period and it was easier to maintain the maximum heat.

Draft Regulation The difficulty now was in regulating the forced draft. By firing with natural draft it was impossible to get enough excess air into the kiln to bring the heat to the bottom. In using forced draft care had to be taken not to get too much pressure in the kiln or the fire would burn back in the hopper, the coal would coke, arch over in the mouth of the hopper, and stop feeding, allowing the heat to go down. Considerable difficulty was experienced until it was learned just how much pressure could be carried.

Results to Date

At the time this paper is being written seven firings with the stokers have been made and, as yet it is difficult to decide whether the stokers are a success or a failure. Nut and slack against lump coal in the hand-fired kilns have been used which has saved a little money, not due to

less coal used, but due to the difference in the price of the coal. The amount of coal used has been greater with the stokers than the average hand-fired methods previously used. The firing time has also been longer than with the hand-fired kilns; the best time made so far has been a few hours less than 8 days.

Among the main difficulties in the operation of the stokers was inability to raise the heat fast enough after watersmoking; in maintaining the heat at a high enough temperature such a high local heat was produced that it was destructive to the brick in the kiln and also to the fire brick used in the construction of the stokers.

METROPOLITAN PAVING BRICK COMPANY
CANTON, OHIO

Discussion

JOHN D. MARTIN: The idea of using larger stoker furnaces than hand-fired furnaces on kilns is probably not because of a belief that firing economy could be secured with fewer furnaces, but because no stokers small enough to fit into the usual hand-fired kiln furnace have been available. With one exception, the ceramic industry has been trying to use stokers which were not designed for use in kilns and because of using stokers more fitted for boiler or furnace heating it has been necessary to depart from what has been considered good kiln practice. It is difficult to avoid the conclusion that satisfactory results cannot be obtained by the use of stokers larger than the usual kiln fire box; they can be merely hoped for and if these hopes are not confirmed, the idea of stoker firing will be condemned.

Stoker firing of coal has been proved economical. Modern power plants can make power as cheaply as the water power plants, due largely to stokers. The only difficulty to be overcome in adapting stokers to kiln firing is to find an installation which will justify its cost in spite of the fact that on periodic kilns it will be required to stand idle a considerable part of the time.

Stoker More Than Coal Feeder

The stoker which was designed to fit the periodic kiln fire box and offered to the trade some years ago was not a success because it was merely a coal feeder, did not use forced draft, and had no positive means of advancing the whole of the fuel bed toward the ash discharge.

When we began to investigate stoker firing seven years ago, we could find no small stoker of a size which would take the place of the ordinary kiln furnace grate and we were told that it would be impossible to make such a small automatic stoker work successfully on account of an excessive discharge of unburned fuel with the ash. Even the smallest semi-automatic stokers were not of a proper design to be put in a kiln

setting; nor could they be driven in groups which is the proper way to drive a number of stokers on a kiln to get uniform heat distribution.

More Small Stokers In the experiment reported by Theobald there is a ratio of $13^1/_2$ square feet of kiln floor to 1 square foot of stoker grate area and this took the place of a ratio of 7 to 1 for hand firing practice on the same kiln. They have probably been burning on high fire more coal per hour on the five stokers than they would have burned in hand firing. And yet with this increased rate of coal consumption, the time and coal required to complete a firing has been greater. There is evidently something radically wrong here and our stoker experience seems to provide the solution as we have achieved notable fuel and time savings with a ratio of kiln floor area to stoker grate area as high as $12^1/_2$ to 1.

Our answer to this is smaller stokers and more of them. Our stokers have a grate area of 7 square feet while the smallest one Theobald used had a grate area of 18 and the largest 27 square feet.

Our Developments Our first stoker firing was made in 1920 and we have been working constantly since, changing our ideas and designs and spending thousands of dollars on this problem. We have finally produced a successful small stoker which is completely automatic and so designed as to be driven together in groups from one point and can be used for firing either rectangular or round kilns.

Our stoker has a round, rotating, conical shaped grate with 7 square feet of area, is of the underfeed type, burning slack coal with forced draft.

We use one forced draft fan to a kiln, the draft and coal regulation being separate. The stokers are all operated together as a unit with a variable speed motor having a speed ratio of 4 to 1; any speed in this range is possible, and we might say, necessary. Each stoker requires $^1/_5$ H.P. for its mechanical operation together with about $^1/_6$ H.P. for its forced draft. A kiln requiring 10 stokers can be operated with $3^1/_2$ H.P. on high fire.

The coal is positively delivered to the fuel bed and positively advanced over the grates, the ash being discharged continuously and not dumped periodically. Siftings through the grate are also continuously removed from the wind box underneath. The ash from off the grates is discharged outside the wind box.

Should a stoker be stopped for any reason, the remainder of them in the group continue operation.

With the light draft we use, a minimum of fine ash is deposited on the ware for such practice while our fuel bed temperatures are not so excessive as to cause real clinker trouble.

In one of our face brick plants the best result with hand firing a kiln with egg coal to 2200° F is 1300 pounds of coal per thousand brick. In

this same plant using slack coal of the same grade as the egg, we have recently made a stoker firing of the same brick with 825 pounds, a saving in coal of 36% and a reduction in time from $7\frac{1}{2}$ to $5\frac{1}{3}$ days. This was on a 30-foot round downdraft kiln having ten stokers with a ratio of 10 to 1 of floor to grate area.

With our ideas working out so well we feel enthusiastic about the possibilities of stoker firing especially as we have been able to reduce the cost of the stokers by using castings and reducing the machine work to such an extent that they show a very handsome return on the investment.

The Straitsville Impervious Brick Company
New Straitsville, Ohio

FIRE-TRAVEL IN CONTINUOUS KILNS[1]

By Alfred B. Searle

ABSTRACT

A general comparison of tunnel kilns and other continuous kilns is made taking up such questions as size, condition of the brick entering the kiln, draft, and rate of firing. As this is based on European practice, discussions based on American practice are appended.

General Statement[2]

The average rate at which the fire travels forward in a continuous kiln used for firing brick is 6 inches per hour, so that in a chamber 12 feet long, the fire usually moves forward at the rate of one chamber per day. This slow rate of travel was not regarded as serious until about 25 years ago, when it was found that a much more rapid rate was readily attainable and since the advent of the tunnel kiln, in which the goods moves forward at the rate of 5 to 6 feet per hour, the question as to how to increase the rate of fire-travel in ordinary continuous kilns has again come to the front. The tunnel kiln must, apparently, be made very narrow or irregularity in heating occurs, and this narrowness restricts the output to about one thousand brick per hour, a figure which is scarcely consistent with the cost of such kilns when compared with that of an ordinary continuous kiln of equal output. The tunnel kilns have shown, however, that rapid firing is possible with many clays and the immediate problem is how to increase the speed of continuous kilns. To solve this problem let us compare the two kilns a little further.

Tunnel Kiln

Length (1) A tunnel kiln less than 300 feet in length is seldom satisfactory for brick made of plastic clay, yet most ordinary continuous kilns have an effective length of only 200 feet, a difference which is serious and, as a matter of fact, goes far to explain the slow firing of such kilns.

Predrying (2) The brick entering a tunnel kiln must be perfectly dry and usually they are warm. In an ordinary continuous

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Heavy Clay Products Division.) Received November 9, 1927.

[2] In the present paper it is necessary to explain the following terms since their meaning is not identical in European and American practice. (*a*) *The continuous kiln* is often known as the Hoffman kiln (after its inventor), but also by other special names, is a rectangular kiln of annular form in which the fire travels forward continuously. The Haigh kiln is of this type. The kiln may or may not be divided by partition walls into definite chambers. (*b*) If definite chambers are used the term *continuous chamber kiln* is used. Even when no actual partitions are used, the kiln is supposed, as a matter of convenience in description, to be divided into chambers though the divisions are wholly imaginary. (*c*) *A tunnel kiln* is a kiln in which the goods are placed on cars and travel through the kiln. (*d*) *A chamber kiln* is a continuous kiln, as just described, divided by partition walls into a definite number of chambers. It is sometimes termed a *compartment kiln*.

kiln, on the contrary, they usually contain 5 to 6% moisture and sometimes as much as 10%, all of which must be removed before the "firing proper" can begin. In other words an ordinary continuous kiln is used as a drier as well as a kiln, and drying slows down the rate of firing very seriously. Moreover, a kiln is not an efficient drier, so that it would be cheaper to dry the brick in a separate drier designed for the purpose. The reason brick made by the stiff-plastic or semidry processes are sent direct to the kiln without drying, is that the cost of handling into and out of the drier is saved and, when ordinary methods are used, this cost is serious. With modern methods of handling and a "cupboard" type of drier, one man can handle all the brick made by a machine, and the benefits gained by drying and by more rapid firing, enable this man's wages to be paid and a large saving to be effected.

Draft The conditions of firing and draft must be carefully regulated, and maintained as constant as possible; the fuel in small quantities at a time supplied automatically (if this can be arranged), the draft not less than half an inch (water column) at any part of the kiln, and the carbon dioxide in the gases about 9%.

Summary The problem therefore narrows itself down to (*a*) using a kiln of sufficient effective length, 300 feet being regarded as a minimum for most brick clays, though a shorter kiln may be used in a few instances; (*b*) admitting only dry brick into the kiln or, as a less desirable alternative, increasing the length of the kiln still further so as to permit the drying to be finished therein without delaying the firing; and (*c*) using a fan or other means of creating a sufficiently intense draft to overcome the friction in so long a kiln.

Chamber Kiln

Size The chief difficulty experienced with both tunnel and chamber kilns is to find space for a kiln of the necessary length to insure a rapid fire-travel. A simple design of a chamber kiln consists of two parallel rows of "chambers," or their equivalent, which involves a ground-length of about 170 feet as a minimum. If each "chamber" is 15 feet in length, there would be 20 chambers, but as very long chambers are sometimes difficult to control it is usually better to have 24 chambers each 12 feet 6 inches in length. This assumes that the brick or tile are perfectly dry; otherwise, a sufficiently large additional number of chambers will be needed to provide for drying the contents without delaying the firing and may increase the total number to 30 or even 36 chambers.

The width of the chambers (*i.e.*, the measurement at right angles to the fire-travel) depends solely on the output. By using transverse arches, it can be increased to any desired extent. Thus, a chamber 20 feet wide will have precisely double the output of one 10 feet wide, as

the progress of the fire will be the same in both cases. In other words, the effective length of the kiln is properly determined by the rate at which the fire is expected to travel and the length of time required for heating the goods, but the width is determined solely by the output. Where the output is small, a very narrow kiln may be wholly satisfactory and economical in fuel.

In order to provide for the effective length and yet keep the total length of the kiln as short as possible, the late Jacob Bührer of Switzerland many years ago, devised the kiln known by his name. In this the kiln may be imagined as having been cut up into a series of short lengths which are built parallel to each other, the flues being arranged so that the gases travel along one series of chambers in one direction and along the next series in the opposite direction, these changes in direction being repeated until the end of the kiln is reached. A final series of chambers is arranged so as to connect the "beginning" of the kiln with its "end" so that its action may be continuous. Although this kiln has not been used extensively in the United States, it is undoubtedly designed on principles which are broadly correct. When suitably adapted to local conditions, a kiln of this type, provided with a powerful, slow-running fan instead of a chimney, can be worked with a fire-travel equal to and sometimes greater than that of a tunnel kiln, and as the width of the kiln can be increased to any desired extent the output is practically unlimited. Considerations of convenience, and the necessity for applying artificial ventilation to cooling very wide chambers, limit the width, in actual practice, to 28 feet. This corresponds, with a fire-travel of three feet per hour, to an output of 141,000 bricks per day from one kiln.

Drying It is a curious fact that the faster the fire travels, the greater is the amount of waste heat available for purposes outside the kiln and the smaller is the consumption of fuel. For this reason, it is easier to dry brick and tile with the waste heat from a continuous kiln with a rapid fire-travel than from one which travels more slowly.

Rate of Fire-Travel

A rapid rate of firing is impossible for clays or other materials which contain much carbonaceous matter and tend to produce black "hearts," or "cores" in the goods. When such materials have to be fired, the only course is to fire them at such a rate (not necessarily uniform throughout the whole firing period) that the carbonaceous matter is fired out before any appreciable sealing of the external pores occurs. The later stages of the firing may then proceed more rapidly. Some clays and shales are very tiresome in this respect because they contain more carbonaceous material than would, if applied externally, suffice to fire them, and it is often very difficult to control the combustion of this matter so that it will burn away without developing more heat than is desired.

With clays in which no trouble from carbonaceous matter occurs, the chief disadvantage of a rapid fire-travel is the slow rate at which the chambers cool. This may necessitate artificial ventilation and cooling in order that the men may draw and set the bricks in reasonable comfort. This disadvantage is wholly avoided in tunnel kilns, but at a great increase in cost.

To prevent misunderstanding, it should be stated that the author has no financial interest in any type or make of kiln, and any names which have been mentioned are included for the sake of simplicity of description and are not intended as a recommendation.

CONSULTING CERAMIST
SHEFFIELD, ENGLAND

Discussions

F. M. HARTFORD:[3] We are able, in this country, to operate our kilns evidently much faster than has been A. B. Searle's experience in Europe. A 350-foot car-tunnel kiln at the Ohio Clay Co., Cleveland, Ohio, is operated regularly at a 36 car per day schedule, which gives a car movement of approximately 10 feet per hour and produces 3000 brick per hour or 72,000 brick per day. These brick are architectural common brick, used for face brick purposes. The clay from which they are manufactured is exceptionally high in sulphur and carbon. This production of 3000 per hour (144 tons per day) is not uncommon with direct-fired tunnel kilns in this country. It might be stated here that the cross-section of this kiln is about 6 feet square. We present the above information, as it may aid in increasing the rate of fire-travel in compartment continuous kilns, although due to the small cross-sectional area in a car continuous kiln, we do not believe that this rapidity of fire-travel can actually be accomplished in a compartment kiln, but it can be approached.

We believe that we can more nearly line up laboratory firing of sample brick with commercial firing of great tonnage by reducing the area of the cross-section of the commercial setting and securing tonnage by speed of firing. In normal practice, it is very difficult to fire brick in commercial kilns nearly as rapidly as they can be fired in a laboratory kiln, but the smaller the cross-section of the setting the more rapidly can the brick be treated in the watersmoking, dehydration, oxidation, maturing temperature, and cooling periods. We are firing brick in commercial kilns now much more rapidly than we were able to do 10 years ago. The smaller the cross-section of the setting, the higher the speed of firing, and the less investment there will be tied up in brick in process of firing.

P. NICHOLLS:[4] A. B. Searle's paper can be described as a summary

[3] Received November 12, 1927.
[4] Received Novembe 23, 1927.

of the present state of the practice of firing in continuous and tunnel kilns and a comparison of the two types in the practical fundamentals of their operation. Presumably the figures he gives are based on European practice and it can be left to the operators of such kilns to compare them with American practice. The paper could have been longer to give a more complete analysis of the subject, since it opens up the whole question of the possibilities in the design of the two types of kilns.

Although the development of the optimum method of operation must come largely from practice yet it is dependent on a number of fundamental factors, and theoretically, it could be determined by computation, using data and coefficients derived from laboratory experimental firings. It is to be presumed that the designers of such kilns have reduced the problem to the equivalent of empirical formulas, but there is room in the literature for a complete analysis based on fundamental factors of ceramic requirements, combustion, and heat transmission. Such a treatment would at least be useful as a basis of reference.

Is it not necessary to make clear that there must be some reservations when comparing the rate of fire-travel attained in a continuous kiln with the rate of movement of the ware in a tunnel kiln of equal length? The effective length of the continuous kiln will be less than that of the tunnel kiln by the length of the drawing and setting portion, and by approximately the full length of a single section because of the intermittent operation. Presumably the author recognizes this although he does not definitely state it.

Some question might be raised on the permanent truth of the author's statement in the opening paragraph that the tunnel kiln must be very narrow. Undoubtedly difficulties will increase very fast as the width is increased, but it should be possible to overcome those of irregularity in heating by design, distribution of the products of combustion, and by control of drafts. Should the difficulties in doing this be essentially greater than in a wide continuous kiln, and particularly in a type where the gases make semicircular turns?

The statement that the faster the fire travels, the greater is the amount of waste heat available for purposes outside the kiln and the smaller is the consumption of fuel, needs enlargement. It is not clear whether this includes the additional fuel that would have to be used for drying if the waste heat were not available, or whether "fire-travel" is used in the general sense of the opening paragraph of the paper or in the more restricted meaning of rate of combustion and gas velocity. An increased rate of firing will give higher gas velocities and higher gas temperatures through the kiln, resulting in a higher rate of heat transfer to the ware and probably more uniform distribution.

resulting in a shorter time of firing and less total heat loss to the kiln walls, but with a higher exit gas temperature. The possibility of saving of fuel will depend on the utilization of the waste heat and there will be some optimum rate of firing, which will be fixed by the installation and the ware being fired.

The foregoing comments are not intended to be favoring any particular type of kiln, but are intended to support the suggestion that there is need of more thorough treatment of the principles and computations connected with such kilns.

ELLIS LOVEJOY:[5] Searle's use of the terms tunnel kiln and continuous kiln is a bit confusing and shows the need of accurate definitions of these several types of kilns.

It is assumed that the type which he designates as "tunnel" is what we call "car-tunnel" kiln, and his "continuous" kiln we call "tunnel" kiln to distinguish it from the compartment types. Our tunnel kilns, in fact all types of kilns, are very commonly known by the name of the designer, as the Hoffman or Haigh tunnel kiln, Youngren, Richardson, or Dunn compartment kiln, the Dressler, Zwermann, Harrop, Faugeron, and other car-tunnel kilns.

The classification of our continuous kilns is:

(1) Car-tunnel regenerative kiln
(2) Tunnel regenerative kiln
(3) Compartment regenerative kiln
(4) Open top regenerative kiln
(5) Scove continuous kiln, not regenerative

The last-mentioned is often designated as a continuous kiln and it is continuous in its operation. The setting begins at one end of the long kiln building and when enough arches to fire are set, the setting is blocked off by a dead wall, the kiln scoved and platted, and the fires started. The setting continues until second, third, fourth, etc., sections are complete and the firing follows the setting. Meanwhile the first and subsequent sections are fired and cooled, and unloading begins. The kiln is then in full operation and as truly continuous in its operation as any continuous or semicontinuous kiln. When the other end of the kiln building is reached, the setting returns to the original starting place, and thus the operation continues until the end of the season, and the end of the season is determined by the operation. As long as the unloading keeps pace with the setting, etc., the season is open, but when the setting finally overtakes the unloading, and the kiln is full from end to end, the season of operation ceases.

As Searle states our car-tunnel kilns firing brick exceed 300 feet in length and this length is essential because of the rate of movement of the ware through the kiln, yet I cannot agree that a similar length

[5] Received November 30, 1927.

in a tunnel kiln or a compartment kiln will serve to increase the rate of advance of the firing.

What Dr. Searle designates as stiff-plastic or semidry processes, we know as dry press and a very limited number of dry pressed brick are fired in tunnel or compartment kilns.

A comparison of the operation of the two types of kilns in this country can be made on dried stiff-mud brick which are extensively fired in both types of kilns.

Our car tunnel kilns are producing 35,000 to 40,000 brick per day. One kiln claims 72,000 brick per day, but these are small in size, hollow, and the shale contains carbon which may aid in hastening the firing. We are, however, in several plants producing 35,000 to 40,000 face brick per day, but they are small compared with the "English" size as we know it, unless there has been some change in the size of the English brick. This may account for the differences in the quantity of brick output mentioned by Dr. Searle and as given above.

Our tunnel kiln setting, as stated above, is not wet brick as seems to be the case in England, and the slowness of the operation compared with that of the car tunnel kiln cannot be attributed to that cause.

A tunnel kiln 300 feet long as suggested by Dr. Searle would have 25 sections 12 feet long and it would not be fired as a single kiln; instead, part of the time two series of fires would be running, in other words the kiln would be operated part time as two kilns, and this would not be the case if the greater length permitted faster operation.

All of our later tunnel kilns and many of the older ones have fan draft and the slow operation is not due to any weakness in the draft; a very common construction is a double parallel battery instead of a return flue, or starting the firing anew.

The slow rate of advance of the fires in the tunnel kiln compared with the rapid advance of the ware in the car-tunnel kiln is a condition and not a fault due to setting wet brick. Weak draft and limited lengths are, in a few installations, faults which limit the rate of advance of the fire.

In the car-tunnel kiln the rate of advance is largely regulated by the length of the kiln. If we had but a few car lengths in the water-smoking zone, a single pair of fires in the firing zone and a corresponding short cooling zone, the advance of the ware must be slow. We are moving the ware through these zones and the faster the ware is moved the longer the zones must be to properly do the work. There is a limit, of course, since we cannot control the drop in the water-smoking heat curve over an unlimited distance, and the rate of advance is determined by proper watersmoking conditions, assuming that there is no weakness in the furnace zone as has happened in some of the earlier installations.

There is no limit in the air supply for combustion nor in the rate of combustion.

The tunnel kiln on the other hand is limited in the air supply available over the extended distance through the firing zone. The fires nearest the cooling sections get an abundance of air and in this section we have a maximum rate of combustion and maximum temperatures. The next section gets less air, and in advanced sections there is no free air available for combustion and the coal dropped into the flues in such advanced sections does not ignite even though the brick may be at a red heat or closely approximating it from the combustion gases coming forward from the rear firing sections. The rate of advance in the majority of instances is not delayed by any of the causes mentioned by Searle; instead we cannot advance beyond the ignition point, beyond the point of no free air to support combustion.

There is a wide difference in the numerous operations, some going faster than others for one reason or another, and often the difference is due to skill in handling the operation; yet, without the handicaps given by Searle we cannot advance the fires in a tunnel kiln at nearly the rate of advance of the ware through a car-tunnel kiln.

One reason why this cannot be done, is that we cannot increase the draft indefinitely, which would advance the rate of combustion. If the draft is excessive, we advance the heat in the top of the sections without getting the advance in the bottom, and once the heat has thus run ahead we cannot hope to fire the ware to the floor. The rate of advance is determined by the rate of the heat advance in the bottom of the kiln and to maintain the respective advances (top and bottom) we must have a balanced draft in the firing sections: indeed a negative draft, a pressure throughout the section, due to the expansive force of the hot gases under the pressure from behind and maintained by the resistance ahead. If we greatly overcome this resistance ahead by excessive draft, the heat will soon run to the top of the kiln and the bottoms are lost.

I agree that there is much to be gained in light and frequent feeding of the fuel, in automatic feeding, and in maintaining constant draft, and I would add, in intelligent handling of the operation throughout.

Many of the tunnel kilns in this country are 12 feet wide, some not more than 10 feet, and wider kilns are built up to 16 feet. There may be some wider than this not known to the writer. The objection to the wider kiln is the shorter life of the crown, and the increased up-keep. The up-keep kiln cost of the tunnel and compartment types over that of the car tunnel type, is decidedly in favor of the latter.

The Bührer kiln mentioned, known to us as the zig-zag kiln has never come into use in this country as far as I know, but it has much to recommend it over the ordinary tunnel type. It not only has the compactness

mentioned by Searle, but it can be planned for as convenient setting and unloading as the compartment type, or rectangular periodic kilns, filling the kiln from the factory side and unloading from the opposite side. Where the ware is handled on drier cars into the kiln, the tunnel kiln is decidedly objectionable in labor cost. The load enters the kiln and is transferred to a transfer track and thence to the working face, or turned on a turntable and moved forward to the setters, and this movement must be reversed before the next load can enter.

Dr. Searle mentions the troubles with carbonaceous clays, and in firing such clays the continuous kiln, either tunnel or compartment, has special merit.

Where we fire such difficult clays in a periodic kiln it is necessary to close the furnaces tight after the carbon in the ware becomes ignited, and thus limit the air supply to leakage only. With such limited air supply the carbon in the clay will slowly burn out without greatly increasing the kiln temperature. Following this the furnace fires can be built up and the kiln fired in the usual manner. In one instance it was necessary to close and daub the furnaces for a period of 10 days to get the carbon in the clay safely burned out.

The continuous kiln does this automatically. In the heating up sections in which oxidation is taking place, the air supply is very limited, and it increases slowly as the carbon decreases and the danger of overheating is lessened. A notable example of this is in central Ohio in the Ohio black shale. Several concerns in this section have gone down trying to use this shale, and on the ruins of one of them is a plant which has been in successful operation a number of years using a tunnel kiln.

Occasionally they get some bloated ware, but it is of rare occurrence, where formerly in periodic kilns the several plants seldom got a firing without more or less bloating, and often the loss of the entire kiln.

W. D. RICHARDSON:[6] This is a timely subject and properly introduced by a man of world-wide reputation as a writer on clay-working operations and the manufacture of clay products, and from a country where continuous kilns are in common use in the brick industry.

In discussing A. B. Searle's paper our views must be based on a limited experience with continuous kilns of any kind. There are in the brick industry in America only a few of the progressing-fire tunnel kilns of the Hoffman type, fired from the top, a few more of a modified form, fired in part from the top, but with about three-fourths of the fuel fired in temporary furnaces in the doorways, a few parallel compartment kilns fired with producer gas, and still fewer car-tunnel kilns.

The Hoffman kilns in America are not of the most approved design, though they are most economical in fuel. The firing tunnel is generally too short and the stack draft not strong enough to give a rapid fire-

[6] Received December 16, 1927.

travel. Those that are fired mostly in the doorways, known in this country as the Haigh kiln, have mechanical draft and should make more rapid progress, but as ordinarily operated the combustion gases are drawn out close to the fire, in order to pull the heat down nearer the bottom of the tunnel, so that the kiln often gives irregular results, without the economy of the top-fired Hoffman kiln.

With natural draft the preheating zone must be shorter, since the combustion gases must be taken out of the firing tunnel at a higher temperature in order to keep the stack hot enough to produce sufficient draft. It has been learned that by proper design of a kiln (a longer burning tunnel, a proper plan of setting, mechanical draft, and automatic stokers), a more rapid fire-travel can be maintained. The gases can be used for preheating a farther distance ahead of the fire and can be withdrawn at a temperature much lower. These improvements are said in Germany to reduce the fuel consumption 25 to 35%.

With mechanical draft and automatic coal feeding, more coal can be burned per hour and if the firing tunnel is correspondingly longer, a more rapid fire-travel is assured. In a modern Hoffman kiln a stronger draft may be carried on the chambers under fire without giving such an uneven distribution of heat. In Germany, according to numerous writers in the *Tonindustrie-Zeitung* a common rate of fire-travel in recent kilns is 28 to 32 feet a day, and in some cases, as high as 40 feet a day is reported.

The statement that the more rapid the fire-travel, the more heat there is available for drying brick in a drier outside of a kiln, at the kiln-floor level, is correct and is due to the fact that a longer cooling zone allows the heat to be drawn by the fan from chambers farther back of fire without interfering with the draft on the chambers under fire. On this account the firing tunnel in such a kiln should be longer.

The compartment kiln, because of the much greater width of chamber and greater number of fires, can fire a larger quantity of brick per day with the same distance of fire-travel. Moreover, the gas-fired compartment kiln produces the highest quality of brick, though with a somewhat higher consumption of fuel than the direct-fired continuous kilns of the Hoffman type or the car tunnel kiln; greater expense for repairs is also involved, if the crowns are too wide or not properly constructed.

The few car-tunnel kilns in the building brick industry in America, less than ten altogether, have shown, as stated, that more rapid firing of brick is practical. But they have not yet demonstrated that the tunnel kiln is the most efficient and economical form of continuous kiln for such products, though we are learning more about tunnel

kilns every year and believe that further improvement is practically possible.

The statements by F. M. Hartford in regard to the operation of the Harrop tunnel kiln of the Ohio Clay Company, are misleading, since he omits some important facts and conditions. Some may not know that the brick fired in this kiln are perforated vertically with fifteen holes, and hence can be fired more rapidly with less consumption of fuel. (In order to speak in a language that can be understood the world over, in stating fuel consumption the calories or B.t.u. in the coal should be given, the maturing temperature of the product, and the per cent the weight of the fuel consumed is of the weight of the product fired.) Also it would not be generally known that the word "architectural" as applied to common brick means that much of the product is so irregular and ill-shapen that, a few years ago, they would have gone to the dump, but are now in demand for facing, since there is a present fad for freaks. The swelled brick are due to the rapid firing of a carbonaceous shale. Some architects now prefer these to the most perfect commons and they command a higher price in Cleveland.

The cost of operation of the tunnel kiln is no less than that of a modern Hoffman kiln. The cost of construction and upkeep is more. To be sure the brick are ready for the market in less time after entering the kiln and, in consequence, as Hartford states, "the less investment there will be tied up in brick in process of firing." This statement is often made as an advantage of the car tunnel kiln but probably without due consideration in common brick manufacture. For firing a product that is largely made to order, like terra cotta, special shapes of refractories, or special colors of face brick, a strong argument in favor of the tunnel kiln, is that shipment can be made sooner after placing in kiln. But in the making of stock brick the investment in brick in the process of firing does not cut much of a figure in their cost. For instance, in the kiln of the Ohio Clay Company there are in process of firing about 105,000 brick. In a double-fire Hoffman kiln, turning out the same number of brick per day, there would be in the kiln approximately 500,000 brick. Thus there would be in the latter case 395,000 more brick in process of firing than in the former. Assuming that these brick at that stage have an average cost of $8.00 per thousand, the investment tied up in brick in the Hoffman kiln would be $3160 more than in the tunnel kiln. This constant investment throughout the year at 6% would make an annual charge of only $189.60, which would be more than offset by the interest on the lower investment in the Hoffman kiln.

A. B. SEARLE:[7] P. Nicholls is quite correct in pointing out that the

[7] Reply to P. Nicholls' discussion. Received December 17, 1927.

effective length of a continuous kiln is less than that of a tunnel kiln of the same total length to the extent he mentions. This seemed so obvious that I did not mention it.

His question as to the width of the tunnel kiln raises an important matter. By causing the gases to travel spirally, the width of the kiln can theoretically, be increased to almost any desired extent, but the practical difficulties are very great. Moreover, such a mode of travel is quite different from what occurs in existing tunnel kilns; in my paper, I confined myself to the practical aspect and did not indulge in speculations of a theoretical character. The difficulty could also be overcome by using coal fires, fed through the roof, instead of gas burners at each side, but the use of such fires is limited to common articles and is far from satisfactory.

The term fire-travel, referred to in a later paragraph of Nicholls' comments, is that in the first paragraph of my paper but, to some extent, other meanings are involved. While I have not investigated the matter very closely, I am of the opinion that the increased heat available is partly due to high gas temperatures attained on combustion and to a better distribution of the heat.

I most heartily endorse his final statement as to the need for a thorough investigation of the principles and computations connected with such kilns. My paper was written, however, for a different purpose: namely, to point out a practical result of the comparison of the two kinds of kilns when such comparison is made in a very simple manner which every user can understand. I refrained from a highly mathematical treatment of the subject, such as Nicholls suggests, because it seemed to be too abstruse to be of interest to members as a whole.

FRED BRAND:[8] We can speak at this time from recollection only, as the data collected several years ago in the operation of a continuous tunnel kiln have been lost. We came, however, to some very definite conclusions at the time, which in the main have remained with us.

The kiln was of a horse-shoe shape, where the two straight-aways were connected by a semicircular section. The kiln was laid off into 16 sections of about 20 feet each, and measured about 14 feet to the crown by about 16 feet wide. Coal was used as fuel, part of which was fired through the crown, and the remainder into the more or less improvised furnaces built into the wickets. Fan draft was used. Heat from the cooling chambers was taken to a waste heat drier.

In firing, approximately 100 pounds of slack per thousand $5^1/_2$-pound brick were fired through the crown into "chimneys" left in the setting, and so constructed as to cause the coal, in its downward course, to distribute itself from top to bottom. These chimneys were connected

[8] Received January 9, 1928.

at their bases by both lateral and longitudinal flues or races in the setting. Similar flues led into these from the wicket fires.

Approximately 900 pounds of 1¼-inch lump coal per thousand was used in the wicket firing, which by reason of the flue or race system and the more or less open setting near the walls, acted to a large extent upon the watersmoking chambers ahead. Thus the total fuel requirement per thousand brick was about 1000 pounds.

The limit of this kiln was about 40,000 brick per day, but since the manufacture never exceeded this figure, rate of advance was not uppermost in our minds. Rather we saw the situation in terms of fuel requirement per unit of work accomplished. This item seemed about three times as high as it should have been. In other words the kiln was being operated at a low efficiency, which could be expressed either in terms of fuel requirements or rate of advance.

We regarded the top firing as very efficient, but the side firing as very inefficient. This fact was brought to our attention at one time in a very forceful manner. A car of slack was received which was a little below the accustomed quality, with the result that we lost our fires trying to use it. Here was a case where only 10% of the total fuel requirement was involved, and this no doubt was within 10% of the quality regularly used, but it was not until better slack could be procured that we were able to relight and go ahead.

There was no chance whatever, to dispense with the side firing, for even with them, we had much difficulty in having the forward chambers ready for advancement by the time the one under settle was ready to drop. Thus we found ourselves continually holding up the top firing and forcing the side fires.

After a year or two of this we came to the conclusion that the fundamental difficulty lay in the fact that the kiln called for a combining of at least two distinct and wholly incongruous operations. In the one, little more than the heating of a given quantity of clay was involved, while in the other, a like quantity of clay together with much water which no doubt went through several recondensations. Here then, in the nature of things, there must be a rapid absorption of heat and, with it a sharp drop in temperature, resulting in a very short watersmoking zone, a sluggish draft, and slow advance.

So evident did these facts appear, that we wished that watersmoking in the kiln might be dispensed with, that it might be done in a specially constructed drier; or, if carried on in the kiln that we might make this operation an entirely separate one, extending over a sufficient area that it might keep pace with the other.

The firing zone, thus unhampered could then proceed at almost any desired pace. The draft conditions would be improved, thus at least

the whole of the 1000 pounds of fuel per thousand or 40,000 pounds per day could be fired efficiently from the top. There would be no tendency toward a lag in the lower portions as there would be no delayed watersmoking areas as under the old scheme.

If the watersmoking was carried on in the kiln, we would have cut the drier from the system and used the heat from the cooling chambers for watersmoking purposes only; drawing this heat through the firing holes in the crown over a large area instead of through the limited cross-sectional area of the tunnel. We rather discounted the need of any auxilliary heat for this purpose. We had mapped out a very efficient plan for handling this heat and were sure that it sufficed for this purpose.

As implied, we never had the opportunity to put our theories to test as the problem had been theorized to death before we arrived, and all were more content to go ahead on a so-called "sure thing" than to take a chance. We, however, still hold the conviction that firing in continuous kilns can never attain its highest efficiency unless the two processes are separated.

Buhrer, in a pamphlet, claims 128 feet of fire-travel in 24 hours. A man who saw this kiln in operation said that this rate had been subsequently raised to 135 feet per day, and that the brick were watersmoked previous to their entering the kiln.

A. B. SEARLE:[9] Mr. Hartford's statements seem to apply to special conditions; they are quite ouside of European practice. It would not be possible to comment on them without further investigation beyond suggesting that W. D. Richardson's explanation is illuminating.

Mr. Lovejoy's statement that the fires in a continuous kiln cannot advance as rapidly as in a car-tunnel kiln conflicts with my experience and that of others in Europe, provided that the former kiln is properly designed. We have met similar difficulties, but have always been able to overcome them by lengthening the kiln and providing the necessary accessories such as drop arches and supplementary flues.

Mr. Richardson's experience seems to be so completely in accordance with my own that his contribution to the discussion calls for no reply. It is interesting, however, to note that he differs wholly from Ellis Lovejoy regarding the cost of maintenance of the car tunnel kiln as being greater than that of the Hoffman. If interest and amortization of capital are included in "maintenance" as they should be, my experience confirms Mr. Richardson's statement.

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[9] Received Feb. 1, 1928.

A STUDY OF UNDERGROUND CLAY MINING[1]

By H. E. Nold[2]

ABSTRACT

The conditions in underground clay mining as noted during a survey of the heavy clay industries of Ohio are discussed. The need for greater study of the subject is stressed, especially the haulage, drainage, timbering, panel development, and pillar drawing phases. The solution suggested is a mine as carefully planned and operated as the manufacturing plant in order to increase the percentage of recovery and reduce the cost per ton.

Introduction

During the past eighteen months the Ohio Ceramic Industries Association and the Engineering Experiment Station of the Ohio State University have conducted a survey of the heavy clay industries of Ohio. In the course of this survey the writer visited almost every clay mine in Ohio. The data, suggestions, and recommendations in this paper are based upon conditions found in the underground clay mines of this State.

Conditions in Ohio

The general impression obtained while visiting these plants and mines is that a great deal of the time and energy of the expert technical man has been expended in the attempt to improve and cheapen manufacturing processes and that comparatively little time and energy has been expended in attempting to improve mining practices. The figures obtained reflect this, since, for a given type of manufacturing plant, there is a rather remarkable uniformity of output per man-hour, while in the mines, with similar mining conditions, there is a rather remarkable variation of output per man-hour; this variation being more than 2 to 1. Why should one company with practically the same mining conditions get twice as many tons per day per man employed in the mine as another?

Another noticeable feature is the low percentage of recovery obtained. This recovery ranges from less than 20% to a maximum of nearly 75% (in a few mines) and averages about 30% for the State.

Poor haulage conditions and the consequent high haulage costs are noticeable features in many of the Ohio clay mines; among these are poor track (crooked, rough, and too light rails), poor grades, and muddy track.

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[2] Professor of Mine Engineering, the Ohio State University, Columbus, Ohio.

Drainage also, in many mines, is poorly cared for resulting in muddy and wet track and, at times, poor working conditions at the faces.

The general condition of the mines indicates a lack of mine planning and a lack of study of operating problems.

A seam of fire clay 8 feet thick contains more than 21,000 tons per acre. Extracting 30% means a recovery of 6300 tons per acre and a waste of 14,700 tons. If this were increased (and it can be) from 30% to 65% it would mean an increased output of 7350 tons per acre which would more than double the life of the mine. Stated in other words, if the recovery could be increased from 30% to 65%, 46 acres would produce as much clay as 100 acres are now producing.

It is just as essential for economical operation to plan the mining system and details of operation before the mine is opened as it is to plan the manufacturing plant flow sheet and the arrangement of the units in the plant. The lack of mine planning and systematic operation is the main cause of the present large clay losses in mining. Some of the Ohio clay mine owners are now paying heavily for lack of planning by high haulage costs, large timber expense, and in a number of cases by having to abandon all or parts of the mine.

Clay mining is a fertile field in which to work to reduce costs. A reduction of 10 cents per ton in the cost of mining clay for a plant making 100,000 brick per day will pay 2% greater dividends per year on the cost of the property assuming the cost to be $450,000. It is certain that at least this much of a saving can be made in 90% of Ohio's underground clay mines.

One prominent clay mine operator in Ohio estimates that the cost of clay mining can be reduced 50% in a well-planned and operated mine below the cost in an unsystematic and haphazard operation.

Data Necessary for Mine Planning

The engineer in charge must have certain data before he can intelligently plan the mine. The first step is to obtain information about the location, extent and quality of the clay deposit and as much information about mining conditions to be encountered as may be obtainable.

For strata above drainage a series of openings on the outcrop of the deposit may be all that is necessary to locate and test the deposit. Where the clay seam lies below drainage a series of drill holes offers the best method of testing. A drill, to be satisfactory for this purpose, must make possible the measuring of a complete section of the rocks passed through and obtain a complete sample of the deposit from top to bottom in such form that it may be tested in rather short intervals. The churn drill (ordinary well drill) is not satisfactory for this purpose because it neither furnishes a satisfactory sample nor can

a complete section of the seam be obtained. There are two drills on the market which have been used for clay testing with a considerable degree of success. Both of these drills, the chilled shot drill and the diamond drill, cut out an annular groove and leave a core sample of the clay. Of these two the diamond drill, using the double core barrel, is the best because there is less tendency to break and grind up the core.

The Property Map

In order that the prospecting data obtained can be used to advantage in planning the mine a careful survey should be made and a map prepared. On this map should be shown all property lines, all highways and railroads crossing the property, the location of all streams, the location of all test holes with the elevations at which the clay was found, clay outcrop (if any), and as much of the topography as practicable. The least amount of topography which should be shown is the elevations at various points in stream beds and the elevations on the hilltops. With such a map and a record of all prospecting data the engineer is ready to attack the problem of planning the mine. If the prospecting data have been properly recorded the engineer can place contours on the map which will show the general dip and strike of the clay deposit.

Mine Planning

A map having been prepared, the next step is to so plan the mine as to make possible maximum recovery per acre at a minimum cost per ton combined with a high degree of safety to the workmen.

To accomplish this the effects of a number of factors on operation must be studied. Some of the more important of these factors are mine haulage, drainage, mine development, and mining system. A short discussion of each follows.

Underground Haulage

Having determined the general dip and strike of a clay bed by prospecting it is often possible to reduce haulage costs materially by projecting the mine so that loads can be hauled down-grade and empties up-grade and so that there will be a minimum of long hauls.

Adverse grades greatly reduce the hauling capacity of either a locomotive or a horse. For example an eight ton locomotive can, on good track, pull about 32 loaded cars each weighing 8400 pounds on the level, but can pull only 13 of the same cars up a 2% grade. In other words a locomotive can do less than one-half the effective work when hauling the loads up a 2% grade than when hauling on the level.

The obvious thing to do, whenever possible, is to so plan the mine that the developments will be to the rise and not to the dip.

It is true that, even if the mine is projected so as to take advantage of the natural dip in haulage, local swales will frequently cause adverse grades for short distances. It will usually be found profitable to regrade the main haulage way to cut down or eliminate these adverse grades.

The poor track, previously mentioned is, however, generally a larger factor in increasing haulage costs than the adverse grades. Poor track means frequent wrecks and wrecks are costly not only in labor to clear the track but in time lost at the working faces due to suspension of the haulage, not to speak of injuries to workmen.

It should not be inferred that the mine should always be developed to the rise. This is impossible in some cases and would not be profitable in others because of local topographical conditions. All factors should be so balanced as to produce the cheapest and best operating whole.

One company operating several clay mines in Ohio reported, in 1927, that an engineering investigation of their haulage problem and the subsequent improvement of their haulage conditions has enabled them to reduce their per ton mile haulage costs in the mines to a figure below the costs in 1913 in spite of increased labor costs.

Drainage

Drainage can also be simplified and cheapened if the mine is opened in the lowest part and the workings developed to the rise. By this method the water will run away from and will not collect at the working faces. Gravity also can frequently be utilized to collect the water into sumps from where it can be more cheaply pumped to the surface. It is true that frequently local swales will allow water to collect at the faces but a careful study of the contours can avoid much of this. A test in some mines in the western part of the United States showed labor to be 20% more efficient in dry than in wet working places.

The problem of mine drainage needs more data for its economic solution than are available now to most of the clay mine executives, either for planning or operating the mine.

A drainage survey and a study of the water problem should be made. The following items are among those that should be studied:

(*a*) The dip and strike of the bottom of the deposit (best shown by a contour map).

(*b*) The volume of water made by the mine and its variation from season to season.

(*c*) The location of the water inflows.

(*d*) The relation of water inflow to the area mined over.

(*e*) The best location of pumps.

(*f*) The relative economy of pumping to the surface through the mine openings and through drill holes.

(*g*) The acidity of the water.

(*h*) The possibility of using ditches instead of pumps.

(*i*) The possibility of using syphons.

(*j*) The possibility of standardizing pumping equipment.

(*k*) The relative economy of iron, vitrified, and wood pipe.

(*l*) Whether piston, plunger, or centrifugal pumps should be used.

The intelligent use of data compiled in such a survey has, in many cases, resulted in a distinct lowering of drainage costs. Mines have been better drained and with fewer pumps. It rarely pays to use a number of sizes and kinds of pumps in a mine, with the large investment in repair parts thus made necessary. The writer knows of one case where a lack of an adequate drainage map caused the mine superintendent to discharge water from a pump in the mine at a point such that it flowed through old workings to other working faces instead of to the outside as he supposed it would. In another case the writer is acquainted with a mine where study of the contours on the drainage map made possible the displacing of a rather large pump, operating 24 hours per day, by two syphons which needed very little attention. When last seen these syphons had operated satisfactorily and continuously for over two years and were daily saving the cost of the labor necessary to attend the pump 24 hours per day.

The cost of pumping, however, is small as compared to the damage to the mine resulting from letting the water stand in the entries. Such accumulations of water make it difficult and expensive to maintain track, thereby increasing haulage and wreck costs, and timbering costs. The writer has in mind a clay mine where poor drainage has softened the bottom and pillars, and has thereby loosened the bottoms of the posts of the three-piece sets so that the sloughings from the pillars have crowded in the lower ends of the posts to the extent that they interfere with haulage, making necessary an entire retimbering of much of the main entry before the timbers have rotted or broken. This retimbering at about $2.00 per lineal foot of entry is an expensive item.

Mining Systems Used

Practically all underground clay mines mine by the room and pillar system or some modification thereof. This system as commonly used in coal mines, namely with wide rooms and rather narrow pillars between them, is not a successful system in most clay mines due to the softening and sloughing of the clay pillars which usually takes place. A modification of the room and pillar system which has been called

the "block system" is commonly used. In this system all advance work is narrow, usually not over twelve feet wide. Square or rectangular pillars are formed by driving these narrow openings (entries, rooms, and cross cuts) at right angles to each other on from 70 to 110 centers. This, as can readily be seen, gives a small recovery on the first working but does leave ample pillars to support the overburden and prevent squeeze.

Figure 1 shows part of a clay mine now operating in Ohio. This mine is intended to be developed on the "block system" but in reality is a good example of a poorly developed and badly operated property.

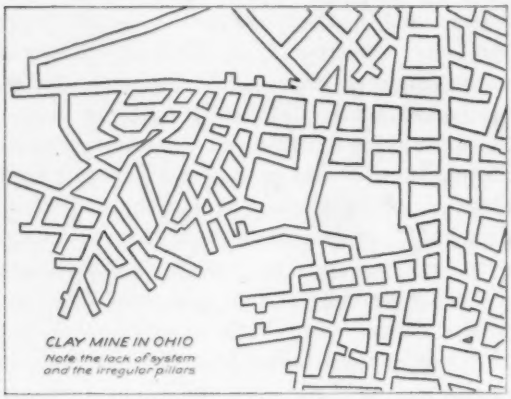

FIG. 1.

Figure 2 shows another "block system" Ohio clay mine which is developing systematically but which is so projected as to make pillar recovery difficult, although it does take advantage of natural dip of the strata to aid haulage and drainage.

Unfortunately in Ohio, in most mines little clay is ever removed beyond the amount taken out in the first advance working, giving a final recovery (as previously noted) of not much over 30% as the average for the underground clay mines in the State. The clay industry cannot afford to go on indefinitely wasting 70% of its raw material reserves. True, our clay reserves are enormous and their exhaustion is not imminent but the ability of most heavy clay plants to operate successfully depends upon a suitable and abundant supply of raw material near the plant. They cannot afford to pay freight charges on raw clay. This being true, the life of the plant is directly dependent upon the amount of clay that can be economically recovered from the territory near the plant.

Pillar Drawing

Materially increased production of clay per acre cannot be obtained by driving wider openings in the mine or by driving openings closer together and leaving smaller pillars. Either of these courses will lead to disaster either in the form of a squeeze or by uncontrolled roof falls. The only way to increase the yield of clay per acre materially is to mine the clay from the pillars. After about the first year the

average underground clay mine should be producing the most of its clay from pillars. The driving of narrow work should be considered as development for pillar drawing and the development rate should be reduced to that necessary to form the pillars as they are needed for pillar drawing.

Most mine superintendents, at least in Ohio, say that they are not yet ready to draw the pillars but expect to mine them at some future

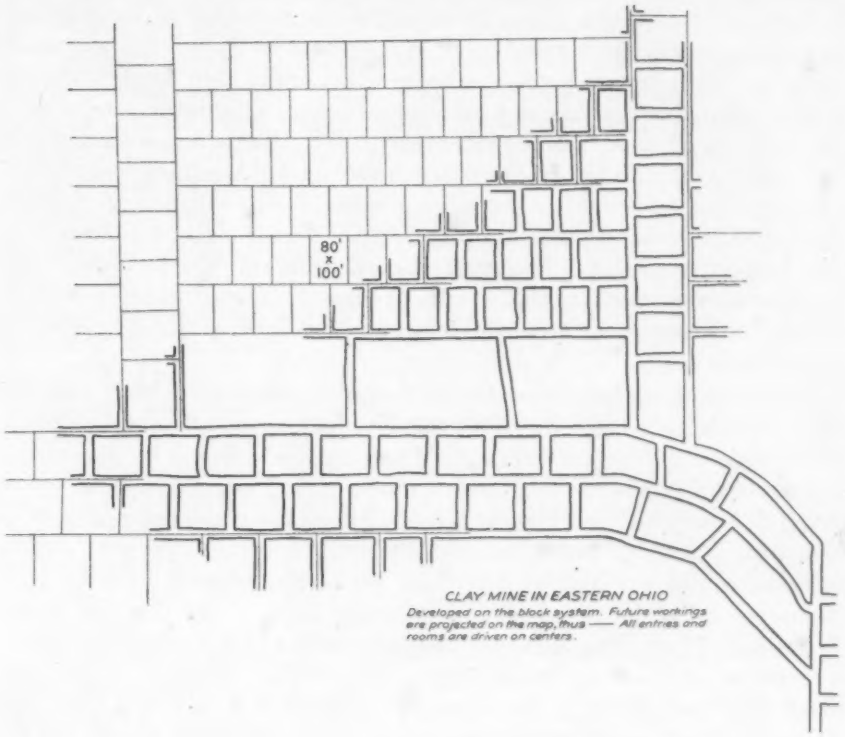
80'
x
100'
CLAY MINE IN EASTERN OHIO
Developed on the block system. Future workings are projected on the map, thus —— All entries and rooms are driven on centers.

FIG. 2.

date when the advance mining is completed. Experience has demonstrated that softening and sloughing of pillars, roof falls, and the expense of cleaning up, retimbering, and relaying track makes the cost of recovering any large part of the old pillars prohibitive and the mine must usually be abandoned with very little of the pillar clay recovered. There is only one time when clay pillars can be successfully recovered and that is soon after they are formed. Get them before they soften and slough off materially; before the timbers rot and break; before the roof caves in or becomes unsafe; and before the track used

in driving the advance work is removed. In general all pillars should be drawn within two years after they are formed. This can usually be done if the mine is systematically developed and the pillar drawing is carefully controlled.

Pillar drawing, to be successful, must be conducted steadily, rapidly, systematically, and in proper sequence. The steady operation prevailing in most heavy clay plants furnishes particularly good operating conditions for successful pillar drawing. The usual method of weakening a number of adjacent pillars by taking a few slab cuts or by splitting the pillar once or twice must result in a squeeze as the work is extended over any large area. Such a squeeze will usually ruin large areas in which pillar drawing has not yet commenced. This work can be successful only when so large a percentage of the pillar is removed that the roof will break and fall in the pillar drawn area. Anything less than a clean roof fall will eventually cause squeeze and stop the mining. A great deal of the success of pillar drawing depends on the method of attacking the individual pillars. The method used must provide for practically complete extraction, together with a means of controlling the roof breaks and must make provision for a safe line of retreat for all workmen at all times.

There are, in detail, several ways in which pillars have been and can be successfully extracted. They all, in effect, start to mine the pillar at or near the inby (farthest in) side or end and mine it by successive cuts retreating toward the outby (farthest out) end. The roof break must be controlled and kept at a safe distance from the retreating face. To control the roof break successfully needs constant care and intelligent supervision. It is usually done by setting a row of strong roof supports, cribs, jacks, or posts just outby from where the roof break is desired. These supports must be so strong as to force the overhanging cantilever of rock to break inby from them. As soon as the roof has fallen the weight on the supports is much lessened and they can and must be removed and a new break line established nearer the retreating pillar face. The writer recently visited a mine where the break line to control the roof breaks in an overburden varying from 200 to 400 feet consisted of cribs built of pieces of hard wood about 6 by 6 inches by 3 feet. They were successful in recovering and reusing about 80% of the timber in these cribs. In another case the break line is composed of hydraulic jacks. In this mine it is a rare occurrence to loose a jack.

The pillars themselves are usually removed by working them open end by a succession of slab cuts or by driving through the pillars a few feet from the inby end and then removing the small protecting pillar rapidly on the retreat before roof weight becomes excessive.

Mining Systems

The ideal method of mining from the standpoint of ultimate cost, percentage of recovery, and safety is undoubtedly a complete retreat system which consists of driving the main entries to the property limits, commencing mining there, developing the pillars on the retreat, removing the pillars as soon as formed, and caving the roof behind the miners. A few Ohio clay mines are now being developed on this system but the length of time required to reach capacity production prohibits its adoption in most mines.

The panel system of mining provides for concentrated mining and offers an opportunity to recover pillars economically almost as soon as they are formed yet does not tie up capital unproductively for as long a time as the complete retreat system.

The panel system consists essentially of a number of small mines or panels, each isolated by pillars and worked as an independent unit, yet so coördinated in their location and operation as to make possible a high degree of efficiency for the operation of the mine as a whole. A panel might be defined as a mine within a mine. (See Figs. 3 and 4.)

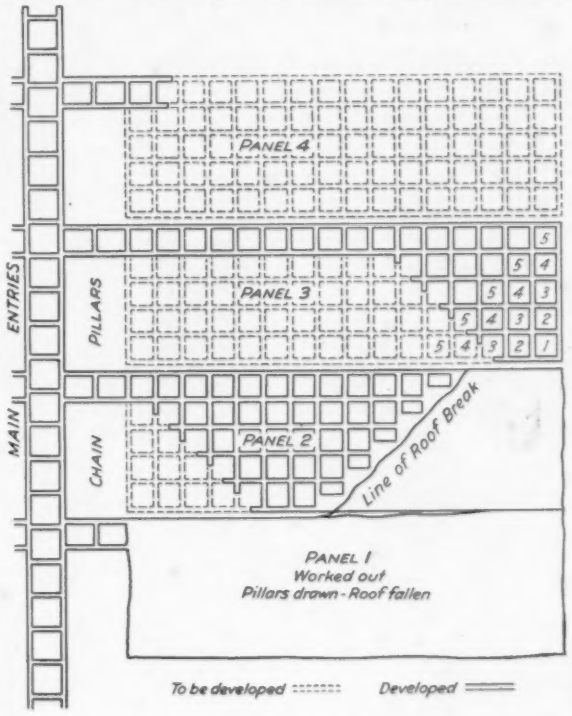

FIG. 3.

This system of mining is not new. It has been operated successfully for years in many parts of the country but so far has not been used in the clay mines of Ohio, although it is now being introduced in at least one mine in the No. 5 bed in the state.

The beneficial effect of concentrated mining provided for in the panel system is not a small item in reducing costs. One panel the size of the one shown on Fig. 3 provides enough working places to

produce 300 tons of clay per day and this is enough for almost any heavy clay plant in Ohio.

Ease of supervision, more tons per acre, low cost of timber maintenance, track serving for both advance and retreat work, cheap gathering costs, and ease of ventilation are some of the obvious advantages of concentration in panel mining.

The Proper Size Panel

It is desirable to have enough working faces in a mine so that the loss of production which might be caused by a roof fall or other cause in one part of the mine can be compensated for by shifting the miners to other faces. Consequently, it would be unwise to make a panel so large that it would produce the entire tonnage desired. For the very large mines the panels should be of such size that working more than one is necessary to keep up the tonnage, while in those mines producing less than 300 tons per day it might be best to have one panel at maximum production at the same time that another one is being developed.

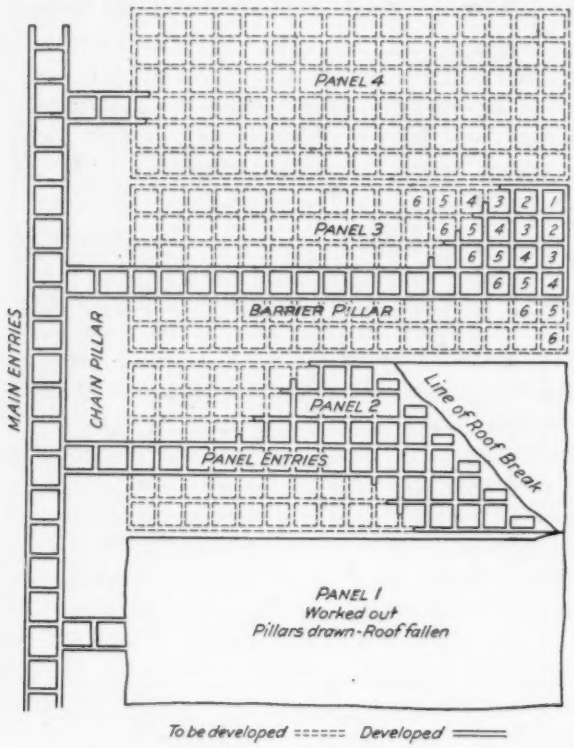

FIG. 4.

After the work on the pillar recovery within the panel is once well under way the output of a panel is in almost direct proportion to the length of the rooms on the panel. The longer the rooms, the more pillars formed from each room and the more pillars worked at once.

The life of the panel, but not the daily production from the panel, depends upon the number of rooms in it. It should, in general, be restricted in length so that one gathering switch can serve the entire

panel without excessively long hauls and be of such a length that the panel entry pillars will be recovered before the retimbering expense becomes too great and before the softening and consequent sloughing off of the pillars makes them difficult to recover.

The best size panel having been selected it is next necessary to determine the location of each panel in the territory to be mined and decide upon the sequence of development and exhaustion of the panels.

This should be done so as to take advantage of grades in haulage, keeping advance workings to the rise when possible and make the system fit within the property lines.

The successful development and operation of a mine on the panel system depend not only upon the determination of the proper size panel but also upon a systematic projection of the mine over the entire territory to be mined.

Sufficiently large chain pillars must be left to protect the main entries and these pillars cannot be removed until the entry is no longer needed, when they can be removed on the retreat system. These pillars left to protect main entries (chain pillars) must be of sufficient size to break the roof on either side without endangering the entries. In some mines 100 feet of pillar on each side may be ample while in others 200 feet or even more may be necessary.

The best size pillars within the panels can be determined only by trial. They must be large enough to avoid a "squeeze" and should be of such size that the retreating faces, in pillar drawing, can be kept moving fast enough to approach the best working conditions of roof control. In general, the faster the pillar is removed the better the roof can be controlled. The pillars should be maintained at about the size now used (from 65 to 95 feet square) until experience has determined a better size for any given mine.

The Development and Working of Panels

The best way to work a panel is by the "retreat" system. To accomplish this the panel entries are driven the full length of the panel before any rooms are turned. The three inby rooms (farthest from the main entry) should be driven first and as quickly as possible. As soon as these three rooms are completed the removal of Pillar 1 (See Figs. 3 and 4) should be commenced. Pillars 2, 3, 4, etc., should be removed in the order marked on the figure. This will develop a line of pillar retreat and roof break such as shown on Figs. 3 and 4.

In order that the pillars are formed so that they can be removed in the order shown it is necessary that the room driving be systematically maintained in a retreating order. (Figs. 3 and 4). One room should always be completed ahead of the pillar drawing so that there may be

no delay in the work. Development of the rooms more rapidly than necessary for pillar drawing is not recommended because of the length of time the pillars must stand before they can be removed.

Figures 3 and 4 are different panel layouts to show how developments may be in either direction to take advantage of grades for haulage and drainage.

The system shown in Fig. 3 has the advantage that each succeeding panel can utilize the roof break developed in the previous panel to aid in starting the new line of break. The panel shown in Fig. 4 has the disadvantage of having to start a new roof break in each panel.

Conclusion

It should be emphasized that the problems of underground clay mining have not been studied as have the clay manufacturing problems and that consequently the mining is unduly expensive and clay losses high.

Specifically, attention should be paid to haulage, drainage, timbering, panel development, and pillar drawing.

The suggested solution is a mine as carefully planned and operated as the manufacturing plant to the end that each acre will produce more clay and the cost per ton be reduced.

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PRACTICAL MINING PRINCIPLES WHICH ARE FREQUENTLY OVERLOOKED[1]

By E. D. Otstot

ABSTRACT

Practical problems of drainage, timbering, haulage, and loading in clay mines are discussed. Suggestions are given for saving time, labor. and expense.

Drainage

The first intimation a plant manager receives that water has been encountered in the clay mine, is a requisition from the mine foreman for a pump and other necessary equipment to clear the working places of water. As other swails are developed in the mine, additional requisitions of this character are sent to the office.

Frequently, after years of development, the original equipment purchased is found inadequate to handle the water, and larger and more efficient outfits are installed, using the smaller units at the newly developed swails in advanced territory.

In other words when a pronounced swail is encountered in the mine, the usual procedure is to install a pump and clear this swail of water; either by relaying the water to another swail, or pumping directly outside the mine.

To solve the drainage problem, the mining engineer should carry levels through the entire mine in entries and rooms, and develop two- or three-foot contour lines over the entire mined area; then a glance at the map will determine specifically whether it will be practical to ditch the water from one swail to another or purchase pumping equipment to handle the water. The fact that considerable ditching can be done to offset the initial cost and the cost of maintaining a pumping outfit should not be disregarded.

Particular attention should be given drainage along haul-ways to keep the track bed above water; hauling through water is a constant source of expense to haulage-way maintenance. Developing contour lines on the mine map will have an added advantage in solving haulage problems.

Personal observation and experience has shown that specific data relative to grades in mines are absolutely essential to economic operation.

The coal mining industry at large, had adopted this method of ascertaining drainage and hauling problems. A recent survey of the clay industry of Ohio, conducted by The Ohio Ceramic Industries Association, however, discloses the important information that this vital item of

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Heavy Clay Products Division.) Received December 23, 1927.

data is almost entirely overlooked in clay mining in the state of Ohio; and probably such a survey in other states would show practically the same results. If information of this character is essential to the successful operation of a coal mine, it most assuredly could be used to advantage in a clay mine.

Timbering

This item has a varied application of practices for different top conditions. The manufacturer who can boast of "good top" in his mine is considered very fortunate. Heavy clay products plants are using their own wares in the form of pillars for roof supports, and brattices in break-throughs in place of wood posts and frame brattices. This method of supporting the top has been found very efficient and should be used in all cases, unless the cost is prohibitive.

When top conditions are such that an extensive timbering program has to be followed in order to support the overburden, a cement mixture of varying thickness is sprayed on the top and ribs of entries, thereby keeping the air from working in the cleavages which causes the top to fall and the ribs to spall off. This is rather an expensive procedure but in some cases no doubt will be found less costly and more efficient than extensive timbering.

Gunite has been used in old shafts which need retimbering. The lagging is removed, anchor bolt brackets inserted in shaft walls at cap timbers supporting same, thus allowing for a replacement of these timbers when necessary. Metal lath is put in shaft walls between sets of timbers and held in place by anchor bolts; gunite is then sprayed on, varying in thickness from three to four inches, shutting off any water that may be running into the shaft and keeping the air from working on shaft walls causing the walls to spall off. This method was successfully used in a shaft 60 feet deep through a sandstone and shale formation; the work was done at night and did not interfere with production in any way. It is substantial and durable, and fifteen months after completion shows no signs of cracking. This work was completed at a cost slightly higher than the estimated cost of retimbering.

The foreman should be able to detect a weak top and have it taken down or support it so it cannot fall, thus eliminating if possible, the costly delay of lost clay production while the fall is being repaired.

Haulage

There are numerous items under this head that seem of slight importance to the average mine foreman. A close observance of the following details over a period of years, however, will show marked results.

(1) See that rolling stock is kept in first class condition at all times.

(2) Keep haulage track to grade and gage; when a piece of track gets out of gage or needs grading, repair it before a bad wreck occurs. (3) Specified dates for inspection of haulage and hoisting equipment. (4) Eliminate excessive grades on tram road from factory to mine, and haulage ways in the mine. Hauling clay over excessive grades wastes either fuel or amperage, depending upon the type of haulage equipment used.

When hauling over a hill into a swail in the mine, the contour lines on the map should be consulted to determine the grades over which the trip must be pulled. Estimate the cost of shooting down top in the swail and taking up bottom on the hill in order to establish a uniform grade, then compare this cost with the extra fuel required or amperage being pulled in order to "negotiate" these grades, together with the wear and tear on the rolling stock, and the "extra expense" of the change will be seen to be worth while.

The same facts are true with animal haulage; one animal will pull a given number of trips to the shaft or mine mouth switch for a certain period, but a time comes when he loses a trip per day, because he has to take a "blow" before he can make the hill; after a time because of this hill he loses two trips per day, and so on, until another animal has to be purchased to keep up production.

The cost of this second animal alone would probably go a long way toward cutting down the excessive grade, thus allowing one animal to continue getting out his production per day for a longer period, and eliminate the cost and maintenance of the second animal together with the wages of a second driver during the period one horse is capable of getting out the production.

Animal haulage should be replaced by motor haulage at a time when the haul from working faces to the shaft or mine mouth is of such length, that the cost per ton for haulage is excessive.

Loading

Loading faces should be concentrated; if widely separated, haulage costs are increased.

If possible shooting should be done at the noon hour and at the end of shifts, when the men are all waiting at the same time for smoke to clear; this will apply to either a tonnage or day loading basis.

Shots should be placed to attain a maximum tonnage per pound of explosives used; a little experimenting along this line often effects quite a saving, both in labor and amount of explosives used.

The clay loading machine is effecting a considerable saving over hand loading methods, when hand loading costs amount to over thirty cents per ton.

In a concentrated mining area one machine can load 200 tons of clay per eight-hour day with three men; loading and haulage costs will average fifteen to twenty cents per ton; depreciation and maintenance costs six to seven cents per ton.

The initial cost of clay loading equipment is high, and tracks and rolling stock must be of sufficient size to efficiently handle the tonnage required. If present mining costs are high, compare these with the investment required to change from hand to machine loading, and ascertain if an ultimate saving could be effected by making this change.

A decided advantage of machine loading over hand loading in this hazardous work is the minimum number of insurance risks on labor.

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BLASTING PRACTICES IN CLAY MINES[1]

By C. H. Coale

ABSTRACT

Blasting materials and methods are described and detail discussion given on the comparative effectiveness of the various explosives under the several conditions met with in clay mining.

Introduction

Clay strata and seams differ considerably in character and thickness. They range, for example, from 4 feet to 20 feet in thickness. Flint clay may occur in the same bed with soft clay. At one point the flint may be above the soft clay, at another, below, and at still another, between two benches of soft clay. Moreover, soft clay, while somewhat more regular in character than flint clay, often varies greatly in structure and thickness, even in the same locality. Clay seams with sandstone above the clay, below it, or between two clay benches are not uncommon. In some regions, both flint and soft clay occur in seams associated with coal measures. At times it is desirable to utilize the overlying coal as a mine roof, while again it may be profitable to mine both clay and coal. Because of these extremely irregular characteristics, it is quite evident that no one type of explosive would suit all conditions.

Kinds of Explosives

There are, perhaps, more kinds and grades of explosives used in blasting clay than in any other class of mining. Straight nitroglycerin, ammonia, and gelatin dynamites of various strengths are used, usually ranging between 30 and 60% in strength. Permissible explosives are used to some extent and blasting powder also, in 1, 2, 3, and 4 F granulations, in some of the soft and semisoft clays. Within the last two years, pellet powder, which is a deflagrating explosive compressed into cylinders and wrapped in paper to form cartridges, has been introduced into clay mines with considerable success.

Nitroglycerin While it is customary to use straight nitroglycerin dynamite in some clay mines, it is generally recognized among explosive manufacturers as an explosive which is unsuited for underground blasting. Straight dynamite resists water well and has a quick shattering effect, but its fumes are quite likely to give trouble underground due to the relatively high per cent of poisonous gases they contain. Since it is more sensitive than either ammonia or gelatin (the sensitiveness increasing with the strength) it is not as safe to handle.

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic Cty, N. J., February 1928. (Heavy Clay Products Division.) Received December 15, 1927.

Gelatin Dynamite Where clay seams are flinty and occur in massive or nodule formation requiring a quick acting explosive, gelatin dynamite is much more suitable. Gelatin under proper confinement is 10% quicker in action than corresponding grades of straight dynamite. Moreover, its fumes are less objectionable than those of any other type of high explosive. It is also dense, waterproof, and plastic. Where a high velocity explosive is required, there is no more efficient or economical explosive for underground clay mining.

Clay miners oftentimes unjustly condemn gelatin dynamite. They accuse it of poor execution when the trouble is that they have failed to tamp solidly. It is very important in the use of gelatin dynamite to tamp solidly in order to secure the best results from it. This is best proved by the fact that gelatin dynamite does not do good work in mudcapping. Without proper confinement its action is very much slower than when it is strongly confined in a bore hole. Many clay mines use gelatin with excellent results where conditions require an explosive of a high velocity.

Ammonia Dynamite In some of the semihard or soft clay, it is a common practice to use lower velocity explosives rather than either nitroglycerin or gelatin dynamite. This also applies to clay seams with slips or partings where quick acting explosives shoot out such places or blast the clay in pieces too large for hand loading. Under conditions such as these, ammonia dynamites are used extensively, principally the 30 to 40% strengths. Ammonia dynamite is not so quick or shattering as corresponding grades of gelatin or straight dynamite. The fumes, while more objectionable than those of gelatin, are better for underground clay mining than fumes from straight dynamite. Ammonia dynamite is not as water-resisting or as plastic as other types, but it can be used in wet holes if the wrappers are not broken and the charge is not left too long. In the manufacture of ammonia dynamite, the cartridges are dipped in melted paraffin in order to keep out moisture as much as possible.

Permissible Explosives Permissible explosives are used quite extensively in clay mines, usually where the clay is of a soft nature and a bulky explosive is needed. Permissibles average 135 to 185 cartridges, $1^1/_4$ by 8 inches to the 50-pound case as compared with 102 cartridges for straight and ammonia dynamites. Because of the lower cartridge strength of the permissibles, a greater number of cartridges is required for the charge. They consequently extend farther along the bore hole and exert a more spreading effect than an explosive of higher density, such as regular ammonia or straight dynamites. Under conditions requiring a charge of this nature, permissibles work fairly satisfactorily, as where coal and clay seams are mined

together. The majority of present day permissibles is made with nitrate of ammonia as the principal explosive ingredient and give off very little objectionable gas. The cartridges are also dipped in melted paraffin and resist water about the same as regular ammonia dynamite.

Low Density Ammonia Dynamites More recently, the new low density ammonia dynamites are being used to some extent for the blasting of clay. These dynamites are quite similar in character to regular ammonia grades but on account of their low density they average a much higher number of cartridges to the case. Their cartridge strength is also greater than that of the majority of permissibles, while their velocities are somewhat lower than for regular ammonia dynamite. Many of the permissibles are designed with a low cartridge strength for use in the blasting of coal. Although this feature is an advantage in coal mining, it is often a disadvantage in blasting clay.

Under suitable conditions, the low density dynamites are being used with success and with much economy as compared with regular ammonia grades; *e.g.* 40% low freezing ammonia regularly packed runs usually 102 cartridges of the $1^1/_4$-inch diameter per 50 pounds. A low density ammonia with a cartridge strength of 40% averages 132 cartridges of the same size per 50 pounds. Shot cartridge for cartridge with 40% ammonia, the low density dynamite gives a considerable saving.

The majority of these dynamites could be placed well within the U. S. Bureau of Mines Class A fume specifications, which means that harmful quantities of posionous gases will not be encountered in underground work. Low density ammonias, no doubt, are destined to be more widely used in clay blasting as they become better known.

Blasting Powder Formerly all clay shooting was done with blasting powder and it is still used in some localities. It is perhaps cheaper than dynamite but on account of its many other disadvantages, it is not as extensively used today as dynamite in clay mines. It is not water-resisting and can hardly be used with success in wet shooting. It has a slow, heaving action rather than a shattering effect. It makes much more smoke than dynamite and as it must be made into a cartridge for charging, it is more dangerous to handle. Blasting powder charges in clay mines are usually fired by means of miner's squibs or safety fuse.

Pellet Powder Pellet powder is being used today with excellent results in clay mines where blasting powder was formerly used. It has distinct advantages over granular powder in that it is much more convenient to handle, much safer, makes less smoke, can be gaged more accurately, and gives better execution. Many clay miners

are taking to the use of pellet powder quite readily. It is found that the costs of blasting are no more than with keg powder and it will generally give better results in any clay seam where granular blasting powder is suitable.

In practice, it has been found an advantage to use cartridges only slightly smaller than the bore hole; this, no doubt, being due to the fact that more powder per foot of bore hole can be packed at the back. The $1^{3}/_{4}$-inch diameter cartridge has given excellent results. Pellet powder is being fired by means of miner's squib, electric squib, and safety fuse.

Use of Combined Explosives

In some localities it is still customary for clay miners to use a combination of explosives, dynamite in the back of the bore hole, followed by a cartridge of blasting powder. The powder is fired by means of a miner's squib and the dynamite is detonated by the powder blast. This practice is prohibited in the state of Pennsylvania. There is no particular advantage in a shot loaded in this manner and there is much danger. Unquestionably it is a practice that should not be used under any conditions.

Blasting Cap and Safety Fuse

The majority of clay mines, where high explosives are used, detonate the charge by means of blasting cap and safety fuse. The shooting is off the solid, to use the phrase applied to this method in coal mining. In some mines a standard round of holes is used but generally clay seams are so irregular in character that this is not practical. Fuse is cut in different lengths to get a delay action where it is desirable to light more than one shot at a time.

Misfires and hangfires are always a source of trouble and danger to a clay miner. Most states where clay is mined now have regulations with specific instructions as to how misfires should be handled. Misfires are perhaps caused chiefly by the use of inferior grades of fuse, poor storage conditions for fuse, poorly primed cartridges, and careless tamping of shots. As a guard against misfires, the best grades of fuse manufactured should be used.

Burning Speed of Fuse

The burning speed of fuse varies considerably with the different brands. A rate of 30 to 40 seconds per foot is obtained with various grades. On account of this difference in rate of burning, it is quite dangerous to replace a brand of fuse in use by another without determining the burning speed and making sure all concerned are notified that a change is being made.

A fact not generally known among miners is that the advertised rate of burning speed for any brand of fuse represents the rate in the open

and that there is no standard rate when confined in a bore hole. Some brands of fuse may normally vary in burning speed under confinement as much as 10% from the average.

Proper Storage of Fuse If fuse is allowed to deteriorate through poor storage still greater variation in burning speed is likely to result. Good storage demands a dry place with temperature ranging between 45 and 75°F. Damp fuse is dangerous, as the burning speed slows down and becomes irregular. Experiments show that damp fuse will vary from 17 to 45% in rate of burning. High temperatures may also melt the waterproofing so that it runs into the powder train. This also slows down the burning speed and causes the fuse to become irregular.

Fastening Fuse Cap It is still a practice among some clay miners to use a knife or the teeth for fastening a blasting cap to fuse. This is an inefficient and dangerous practice. Cap crimpers are made for this special purpose and their use lessens the chances of misfire. They are cheap, durable instruments and when properly used will save many times their purchase price.

Fastening Fuse to Cartridge It is a custom in some clay mines to lace fuse through dynamite cartridges in priming. This is also a bad practice as fuse may burn through the covering or side spit and ignite the dynamite before the cap explodes. Dynamite cartridges should be carefully primed in the side or end. Fuse should be cut squarely, not diagonally, and securely tied with cord to the cartridge with the cap imbedded deep enough so that it will not slip out when the cartridge is pushed into the bore hole. In tamping, wooden tamping sticks should be used and extreme care should be taken in loading to avoid injuring the fuse in any way.

Blasting by Electricity

It is to be regretted that only a small per cent of clay mines today blast by electricity. Blasting by electricity has several advantages over firing by means of miner's squibs or safety fuse. It is quicker, more certain, more efficient, and much safer. Moreover electric blasting caps, or electric squibs, are as economical for a miner as blasting caps and safety fuse. Many clay miners object to electric blasting caps because delay shots cannot be obtained.

Delay Igniters If necessary to obtain a rotation of shots, delay electric igniters can be used. Their cost is higher but their use makes it possible to obtain delay action for as many as twenty periods by a single application of electric current. They give much more uniform results than ordinary caps with fuse cut in different lengths. A delay igniter is made up of a copper tube fitted with the necessary wires,

a plug and a bridge wire imbedded in a priming composition, with a piece of high grade fuse crimped into the end of the tube, the fuse varying in length according to the delay. If a delay igniter is to be used with dynamite, a blasting cap must be crimped to the end of the fuse and imbedded in the cartridge in the usual manner. If used with granular or pellet powder, no blasting cap is necessary.

Greater Safety with Electric Blasting

The most important advantage of electric blasting in clay mining is the much greater safety which it affords. This is well proved by the fact that the coal mine compensation rating bureau in Pennsylvania has doubled the charge for the use of fuse in coal mines starting January 1, 1928. Misfires with electric blasting are very rare. In case a misfire does occur with an instantaneous electric firing device, an electric blasting cap or electric squib, that is, a miner can return to his place in safety almost immediately after disconnecting the battery from the missed charge. When a missed or delayed shot occurs with cap and fuse or miner's squib, there is always uncertainty and danger. Four blasting accidents have occured in clay mines within a comparatively short time, all of which can be traced indirectly to the use of cap and fuse. Two were fatal accidents, the others left the victims with permanently crippled limbs. While accidents of this kind are not entirely avoidable, the use of electricity for blasting most certainly would do much toward reducing the hazards connected with the loading and firing of underground blasts.

Storage of Explosives

Another factor in the use of explosives in clay mines often overlooked is the matter of proper storage. It is quite important that all explosives and blasting supplies be carefully stored in a dry, well-ventilated magazine. Blasting caps and electric blasting caps should always be kept in separate storage from dynamite and taken into a mine in separate containers. Supply magazines should be located at a distance from the mine opening, so that in case of fire or explosion the fumes would not be drawn into the air inlet of the mine. It is common practice in many clay mines for miners to purchase explosives in their original containers and have them delivered to a working place. This quantity of explosives in many cases is considerably more than enough for a day's supply. As a result it is left within the mine until used. This practice should be discouraged because of the possible danger and because dynamite loses its efficiency when exposed to moisture and most clay mines are damp to some extent. Detonators should always be kept in a dry place. Damp caps are very likely to give trouble. Undoubtedly, care in the storing and handling of all explosives and

blasting supplies at the supply magazine as well as inside the mine will go far toward lessening the chances of delayed or missed shots.

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Wilmington, Del.

"Permissible Explosives" Not "Permissible" Unless Correctly Used[2]

By C. E. Munroe[3]

"Permissible explosives" cease to be "permissible" if not used in conformity with the carefully specified system outlined for their use by the U. S. Bureau of Mines. The term "permissible explosive" simply indicates that, after thorough tests the explosive has been found safer than other explosives for use in mining coal, provided it is used in precise accordance with the specifications made and provided for it.

A permissible explosive, correctly specified, is a system in which the designated explosive is but one of the factors. The weight of the charge, the kind of electric detonator, and the kind of stemming used must each conform with the specifications, while, further, the shot must not be a depending one, or bored into the solid, or have a burden so heavy that the shot is obviously liable to blow out, and the shot must not be fired in the presence of a dangerous percentage of fire-damp.

In mining coal, conformity with and observance of each item of the above specification is absolutely essential to maintain the permissibility of the explosive used. Hence, if an accidental explosion occurs in which a permissible explosive is involved, the specifications of which have been disregarded, such accident cannot properly be charged against the permissible explosive.

Permissibles are selected by means of carefully prescribed tests, from among explosives developed in manufacture. They are high explosives as they detonate and their explosions, in use, are initiated by detonators. Among the permissibles are nitroglycerin, ammonia, and gelatin dynamite. They are selected because they will detonate and throw down the coal. The fact that any one of these explosives is selected for use as a permissible does not change its nature. It still, in manufacture, transportation, storage, and use, must be treated as a high explosive, as a member of one of the classes of dynamite or its congeners.

If, in the course of manufacture of such an explosive, through carelessness or other cause, it explodes, this can have nothing whatever to do with the fact that this explosive had been designated as permissible when used under definitely prescribed conditions in mining coal.

[2] An abstract of U. S. Bur. Mines, *Circ.*, No. 6051, Dec. 10, 1927.
[3] Chief Explosives Chemist, Bureau of Mines.

In transportation, if an explosion occurs because the explosive is stored in a car with loose machinery, or involved in a wreck or fire, or when taking it into a mine it encounters a stray current or coronal discharge, this can have nothing to do with its permissibility.

In storage, if an explosion occurs because of lightning, or from detonators or other explosives stored with it, none of the causes has the least connection with permissibility and such accidents cannot properly be charged to permissible explosives.

Many other examples under other circumstances might be cited, all showing that permissible explosives, by passing the tests for permissibility and being placed on the permissible list, have not been in any manner changed. Each retains the explosive characteristics it possessed when tested and may be accidentally exploded by any of the causes to which such explosives respond.

Hence, in any instance, when it is alleged that a permissible has undergone accidental explosion or failed in use, it must be proved that it was being used in the mining of coal and in absolute accordance with the specifications; for, if they were deviated from in any particular, the explosive automatically ceases to be a permissible explosive.

Perhaps the factor of age limit should be added to the specifications of a permissible explosive. Time effects changes in everything, the rate varying with each substance and the conditions of exposure. Realizing this, the Bureau of Mines has from the outset urged operators to use fresh explosives. With the introduction of gelatin dynamites it is noted that these age changes which affect the action of the explosive occur sooner with the gelatin dynamites than with other explosives, and yet the former possess properties which make them most desirable for use. It is unfortunate when the properties or behaviors of a few explosives necessitate drafting additional specifications for all. But circumstances sometimes arise to require it.

The quantity of permissible explosives sold in the United States in 1926 was 67,685,416 pounds. This represents an increase of 16% over the volume of sales in the preceding year, and is the largest quantity of permissible explosives sold for use in this country in any year.

RECENT PROGRESS IN ELECTRICAL APPLICATION FOR THE HEAVY CLAY INDUSTRY[1]

By T. B. Huestis

ABSTRACT

The advantages, proved in installations, of electric drives and controls are recited and detailed descriptions are given of the manner and advantages of electric drive and control of the several machines and means of moving the clay and ware in the heavy clay products plants. The paper is illustrated by photographs of installations which have been found successful.

Introduction

The electrical progress in the brick industry is compared in a general way, in this paper, with electrical progress in other industries; some of the more recent electrical applications in the clay industry are described, and possible future electrical problems discussed briefly.

The heavy clay industry has made immense progress but is far behind in the use of electrical machinery, especially electric control of labor saving machinery. Textile mills, paper mills, cement mills, coal mines, steel mills, and many others which might be classed with brick making have made great strides in the last few years in the number and variety of electrical applications.

There is apparently the beginning of an awakening among brick makers to the advantages of electricity as a labor saver and a corresponding realization on the part of machine men to the advantages of adding electrically operated labor saving machinery to their lines. But a great many brick makers and machine men adhere to the old belief that even though it works in these other industries it will not benefit work on the brick yard.

Electricity is the only form of power wherein an extremely small pressure of a contact tip can be made to control immense forces acting at a distance from the point of control. So many different ways can be found of opening or closing an electric circuit automatically that an electrical machine can be made almost humanly efficient. Unlike a man it will always think the same way under the same set of circumstances and for this reason it is the most adaptable power for labor saving machines.

There are thousands of electrically operated devices in every industry replacing men on jobs ranging all the way from minutely delicate machines to such simple devices as those which start a pump when the water in a tank gets below a certain level.

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Heavy Clay Products Division.) Received December 16, 1927.

Why is it that we find so few of them in brick plants? There are the excuses that there are too many contact points on the electrical apparatus, too much dust around a brick yard, too many sulphur fumes from the kiln shed, and yet in a cement mill there will often be a complete electrical substation with individual motor drives for each machine, each controlled by contactors of some sort. There is no brick plant in the country as dirty and dusty as a cement mill. In all brick yards there are telephones and electric lights all operated by contacts of some kind, and it is admitted that the light switch and telephone box are far from dirt proof.

The fact is that any properly designed contact will function properly in the dustiest place. For instance, there is one switch box located under a conveyer in the dustiest part of a soft-mud machine room that has made 15,000,000 contacts and is still in good condition. A dust-proof cover was designed for it, but has never been used.

As for sulphur fumes, in any of the Schrader process sulphuric acid plants of DuPont or Hercules, there are motors and control operating sulphur burners where a person could not stay three minutes without suffocating on sulphur fumes.

Electrified Clay Plants

There are on the market, at the present time, a number of electrical devices for clay plants some of which will be described.

Clay Feeder The problem of regulating the flow of clay through crushers, dry pans, pug mills, and brick machines so that all the machines work continuously with the minimum amount of attention has been studied for years. Figure 1 shows an automatic feed control for a hammer mill. One motor drives the mill itself, another motor drives the conveyer delivering clay to the mill. The conveyer motor is variable in speed and its speed is controlled by the current flowing in the armature circuit of the hammer-mill motor. Therefore, if the mill gets a smaller amount of clay than normal even for an instant, the motor draws less current, the conveyer motor speeds up and increases the amount of clay fed to the mill. The speed remains up as long as it is necessary to maintain a normal flow of clay to the mill. Conversely, an overload of clay causes the conveyer to slow down. Thus an electrical "watch dog" is working every moment of the day.

Transferring of Drier Cars The drier car hump as used in the Chicago common brick plants where the drier cars travel down hill from the offbearing belt to the transfer and from the transfer down the empty return track is generally known. At the end of the return track, the cars are elevated again to the level of the offbearing track by a chain conveyer which pulls them up an incline.

The chain runs continuously even though only about 10% of the time is actually needed for raising the cars.

In a type of self-acting hump recently designed a very simple control is applied to the motor by means of which the motor automatically starts when a car is pushed onto the hump at the bottom and stops again when the car is discharged at the upper end. If two or more cars are pushed on together the controller counts the cars and does not stop the motor until the same number of cars are discharged at the

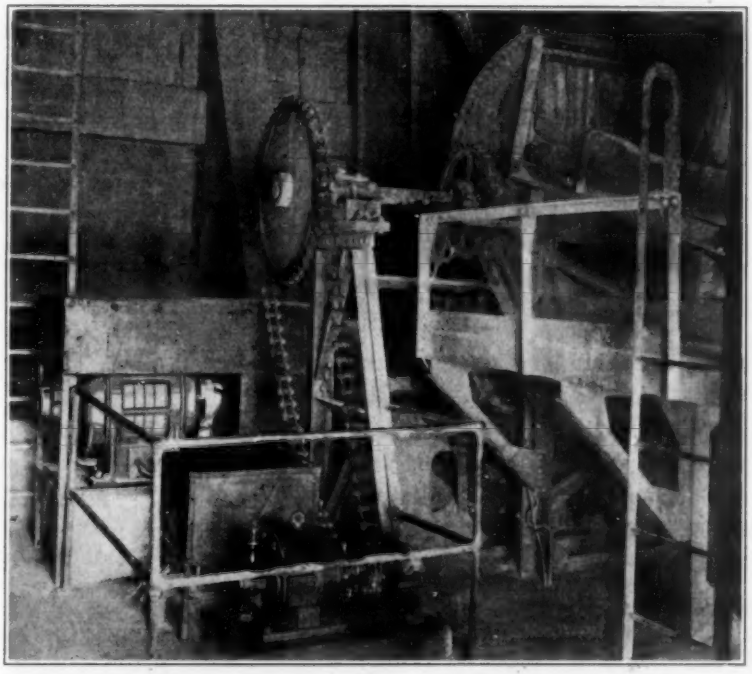

FIG. 1.—Automatic feed control for hammer mill.

upper end. This simple application results in a substantial saving in power and in wear and tear on the conveyer chain. The latter is no small item.

The Cutter One of the most difficult machines to control in a stiff-mud brick plant is the cutter, principally because a plastic column of clay must furnish at least a part of the power to make the cut. Every stiff-mud brick manufacturer has had difficulty with clay columns buckling on the cutting table when the clay becomes too soft to stand the strain or too stiff to be easily cut.

Figure 2 shows an electrically driven cutting table which is now being built where the reel is driven by a variable speed motor controlled

simply by a roller rolling on the clay column. A very light gear train attached to this roll drives a sensitive control switch for the motor which keeps the cutter speed always at a predetermined ratio with the clay column speed. The only power taken from the clay column is

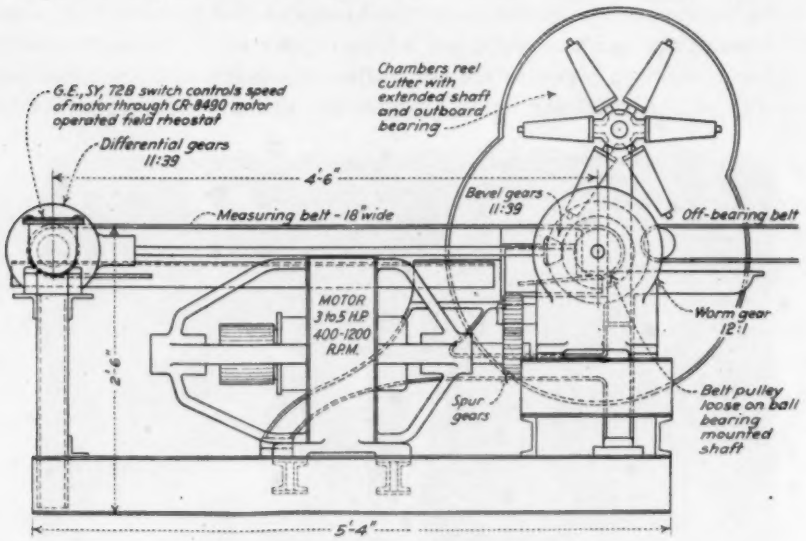
G.E., SY, 72B switch controls speed of motor through CR-8490 motor operated field rheostat
Chambers reel cutter with extended shaft and outboard bearing
Differential gears 11:39
4'-6"
Bevel gears 11:39
Measuring belt - 18" wide
Off-bearing belt
MOTOR 3 to 5 H.P. 400-1200 R.P.M.
Worm gear 12:1
2'-6"
Spur gears
Belt pulley loose on ball bearing mounted shaft
5'-4"

FIG. 2.—Electrically driven cutting table.

the power necessary to turn this controller. The motor itself always has sufficient power to make the cut complete and straight. The brick are always true in length and no deformation of the clay column is possible. A very similar control has been worked out for side cut brick.

FIG. 3.—Portable electric driven centrifugal blower. A kiln of about 1,000,000 brick under heat; Rockwell low pressure fuel oil system.

Air Pressure

Figure 3 shows a portable electric driven centrifugal blower used in the Rockwell low pressure fuel oil system. This illustrates another advantage of electrical power over any other type, namely, portability. By the use of this low-pressure air system substantial savings in fuel costs are made, but the system itself would

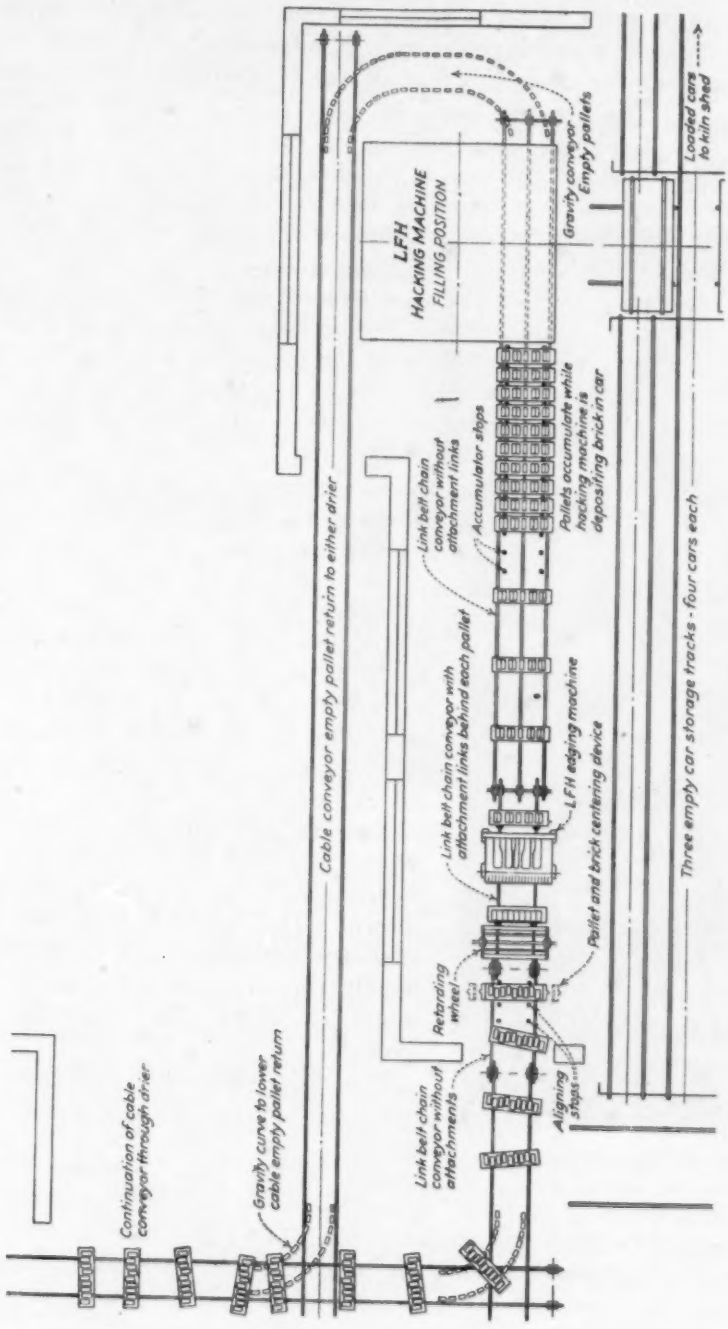

FIG. 4.—General layout of plant.

require an immense outlay of piping and much greater expense if it were not for the small portable power unit. Similar units are in common use on many plants for exhausting downdraft kilns during the cooling period.

Hacking Machinery

The greatest items in labor costs in a brick plant are found in the handling of the ware, hacking, setting, loading, and it is in this field that the greatest advances are now being made in replacing men by electrically operated machinery. The general layout and some of the details of an installation now being built for one of the large Hudson River soft-mud brick plants is shown here. The brick are handled electrically from the drier to the kiln shed, and from there to the barge without hand work of any kind, other than the placing of the pallets on a conveyer in the drier itself. Work is now being done on replacing the hand work in this last item by mechanical means electrically operated. Figure 4 illustrates the general layout of this plant.

Pipe rack driers are used and a cable conveyer runs the whole length of the drier. When the drier is being loaded the pallets of wet brick enter at one end and are replaced on the conveyer by pallets of dried brick which then leave the drier at the other end. By means of gravity curves and a second conveyer the pallets are carried to the hacking house. As shown in the drawing the pallets may be placed on the conveyer at almost any angle as long as they will stay on the conveyer. The brick on the pallet may be disarranged in some such way as here shown. The hacking machine and auxiliary apparatus are designed to handle the brick and pallets in any shape in which they may be delivered.

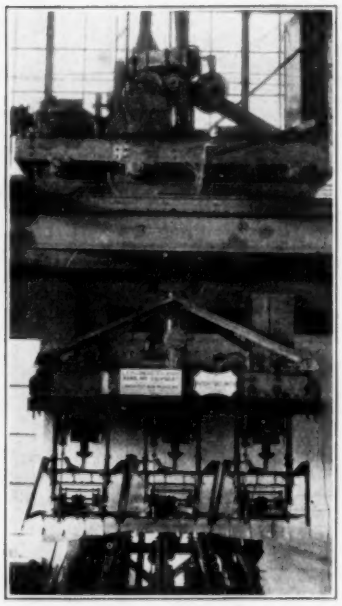

FIG. 5.—Hacking machine.

The first operation performed on the pallet in the hacking house is a squaring up of the pallet at right angles to the path of travel. This is accomplished by means of a simple electric unit which carries two stops, one near each end of the pallet. The pallet coming down the conveyer at an angle strikes one stop first and then swings around to strike the other stop. It is automatically released as soon as it hits both stops and then travels on, square with the conveyer.

The second operation is a centering up of the pallet and a bunching together of the brick into a predetermined position on the pallet. The pallet is stopped momentarily by a second electrically operated stop between two centering jaws. As soon as the pallet is in place a motor is started which moves the jaws together pushing the pallet into a central position on the conveyer and bunching the brick together into the center of the pallet. The pallet is then automatically released and travels on. The time of this whole operation from the release of one pallet to the release of the next is two seconds, or a capacity of thirty pallets per minute. If this machine were manually controlled instead of automatic it would take a man more than two seconds to think what to do next when a pallet came along.

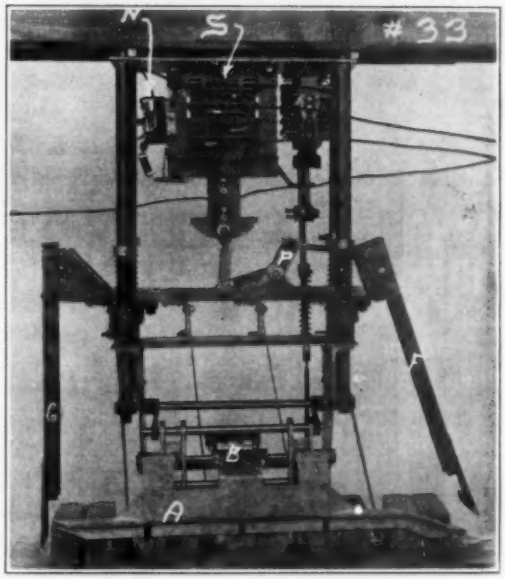

FIG. 6.—Brick grasping unit; receiving position.

The next step is an aligning of the brick on the pallet so that their rear edges are all in line with the rear edge of the pallet. This is accomplished by the retarding wheel shown in the figure. This revolves in the same direction as the pallets but at a slower speed. It therefore retards the brick until they are all properly aligned with respect to the pallet, leaving two inches of the pallet free at the front end.

The next operation is the edging of the brick. A flexible steel apron is dropped onto the front edge of the pallet. The brick are pushed up the incline of the apron by an overhead chain carrying angle attachments. The pallet continues on beneath the apron at the same rate of speed. The brick are then pushed through a series of channels which turn them up on edge. At the end of the edger they are deposited back onto the pallet from which they came edged up in the proper relation for the hacking machine. They are edged up in pairs back to back giving the most stable setting possible for the kiln. The importance of this item is apparent to anyone who has tried to set soft-mud brick all one way.

From the edger the pallets proceed to the hacking machine which removes the brick from the pallets and hacks them onto kiln shed cars in the proper relation for handling with a setter in the kiln.

The hacking machine consists of an overhead trackway shown in Fig. 5, carrying a traveling trolley which in turn supports a number of electrical brick grasping units each capable of picking up the number of brick carried on one pallet. The brick are automatically picked up as soon as they strike a trigger carried on the grasping unit.

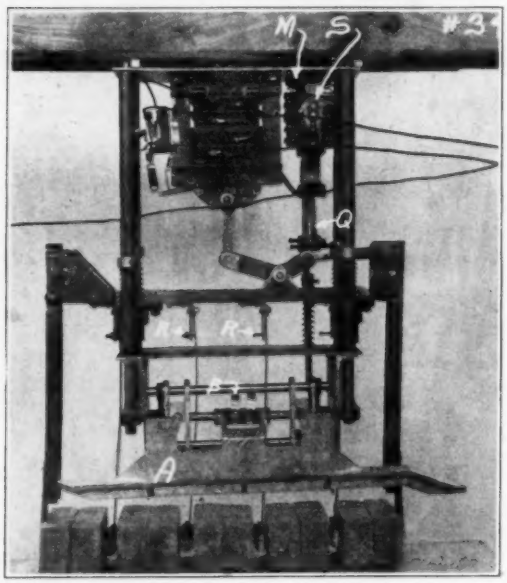

FIG. 7.—Brick grasping unit; brick elevated above pallet.

When all the units are filled the machine automatically carries them to the car and deposits them in the proper relation on the car. Alternate courses are cross-hacked automatically and the different levels are automatically chosen for depositing on the car. The whole operation of the hacking machine is automatic. No manual control is necessary for its normal operation. As long as the brick are fed to it, it will continue to operate up to about 40 pallets per minute, no matter how fast or how slow the pallets come.

Figure 6 shows one of the grasping units designed for a ten-brick pallet. The brick enter the unit spaced apart (as shown in this view) wide enough to allow the spacers to get safely in between. When they strike the trigger an electric contact is made which energizes the electro-magnet shown at the top of the unit.

The pull of this magnet acting through the plate on each side of the brick sweeps the brick together and instantly raises them from the pallet. The pallet passes on down the conveyer and is returned to the machine room.

Figure 7 shows a gripping unit with the brick raised from the pallet.

Figure 8 is a close-up view of the centering and bunching machine.

Figure 9 shows the retarding wheel which aligns the brick on the back edge of the pallet.

Figure 10 is the edging machine showing the brick being removed from the pallet and pushed up the inclined apron.

Figure 11 is a rear view of the edger showing the brick discharged from the edger onto the pallet in edged and paired relation.

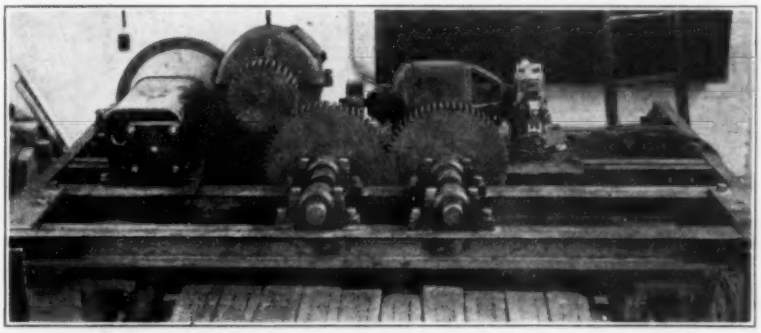

FIG. 8.—Top view of centering device. Brick leaving jaws.

From the hacking house the unit cars of brick are run to the kiln shed by an electric transfer and the brick are set in the kiln by a setter which carries a complete unit of 1200 brick. A new design of setter is to be used which requires no special setting for the finger course. The setter fingers can be inserted in any course of the unit so that a complete unit or any part of a unit may be set at one time. This allows setting the arches as well as the rest of the kiln with the setter and makes a much more stable setting for the kiln than the type of setter in present use which requires a finger course two bricks high.

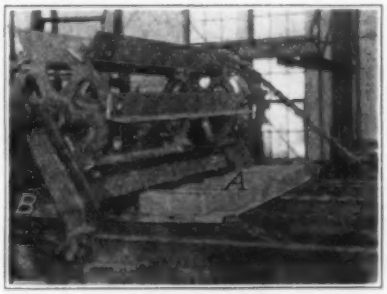

FIG. 9.—Brick entering and alignment wheel at "A". Note disalignment. Brick leaving wheel at "B".

A loading fork removes the same unit from the kiln and either dumps it into containers for railroad shipment or sets it on the barge still in the unit formation ready to be unloaded at the New York end by a similar fork.

Other Uses of Electrical Control

These examples of electrical apparatus now on the market show that although the brick industry may have lagged behind other industries in this respect, strenuous efforts are being made to catch up. There still remain many problems, however, which seem to be susceptible to attack by electrical apparatus. Nearly all plants now use

pyrometers in their kilns. Why is it not possible to use the pyrometer to control the oil burners in some measure? It is done in other industries.

The problem of regulating the flow of clay through the disintegrators, granulators, pug mill, and brick machine is another such problem.

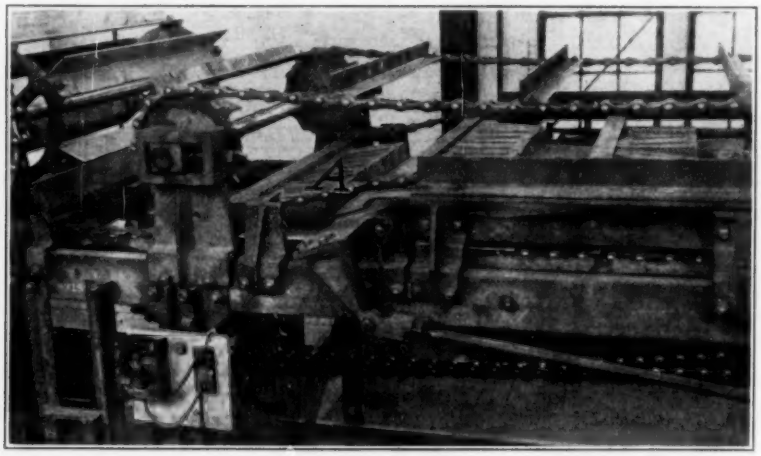

FIG. 10.—Receiving end of edger. Brick leaving pallet at "A" propelled by overhead chain.

It would seem that the speeds of the drive of all of these machines could be regulated interdependently in some such manner as was used in the hammer mill before described. The continual stopping and starting of these machines under present systems is inefficient to say the least. A day's run in a soft-mud plant taken as a typical example showed results as follows: (1) the brick machine operated 96% of the time; (2) pug mill, started and stopped 63 times; operated 70% of the time; (3) granulator stopped 83 times; in operation 54% of the time; (4) disintegrator and conveyers in proportion. This intermittent operation means a waste of power, labor, and time.

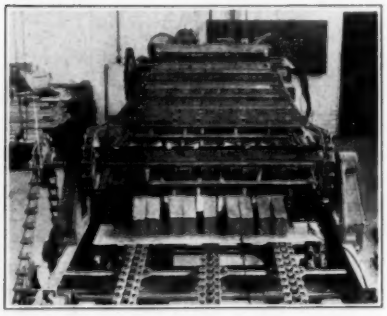

FIG. 11.—Discharge end of edging machine.

In the stiff-mud plants more attention has been given to the problem of feed control. Many forms of feeding machines are in use but these are usually used for feeding ground clay to the pug mill while very little consideration has been given to the feed control of the primary grinding units.

In most brick plants an elevator takes the ground clay from the grinding machinery to a storage bin or screen. If the elevator stops for any reason the clay is still delivered to the elevator and in a very few minutes clogs the elevator so hopelessly that hours of shovelling are necessary to dig it out. A simple control would shut down the grinding apparatus as soon as trouble developed on the elevator.

Another possible place for an electrical watch dog is the reel cutter in an end-cut brick plant. It might easily be arranged to shut down the auger machine when a cutter wire breaks, thus relieving one man from the duty of keeping continual watch over the cutter and resulting in certain saving of labor and material.

Other examples of electrical apparatus on the market might be added and there are other problems which might be attacked electrically but this paper does not aim at a complete review of the subject.

LANCASTER IRON WORKS
LANCASTER, PA.

SOME PHYSICAL PROPERTIES OF ARTIFICIAL ALUMINOUS ABRASIVES[1]

By Ross C. Purdy and A. Ernest MacGee

ABSTRACT

Specimens representing six different bond compositions in soft, medium, and hard grades of artificial aluminous grinding wheels were tested for various physical properties such as hardness, elasticity, expansion, mechanical endurance, impact strength, etc. It was found that the expansion of present commercial grinding wheels and abrasive bonds is much less than that of artificial corundum. The strength of the wheels increases greatly with increasing percentages of bond. The methods of making the various physical determinations are given along with their interpretation.

General

This investigation was made to determine some of the characteristic physical properties of soft, medium, and hard grades of puddled artificial aluminous abrasive wheels.

The test pieces employed in this investigation were made by different manufacturers. The grinding wheel test pieces were made with 24-straight-grain artificial corundum. Thus, there were test pieces representing five different "regular" bond compositions, *A*, *B*, *C*, *D*, and *E*, arbitrarily chosen to represent the different companies.

All test pieces were made by the regular puddled process. The general process of manufacture consisted of puddling, drying, shaving to approximate size, firing, and turning to exact size. The test pieces were imbedded in placing sand and fired in the commercial coal burning kilns employed at the various factories. The heat treatment varied from cone 12 in 70 hours to cone 10 in 120 hours.

To determine what variations in physical properties were due to differences in plant practices, each company made a set of test pieces, using 24-straight-grain and a "special" bond. This bond was the same for each factory.

The Physical Tests

Hardness The relative grade of the test pieces was determined by measuring the penetration of a $^3/_{16}$-inch twist drill under a weight of 67 pounds, 13 ounces. After being seated the drill was given two forward and two backward turns, each turn being two-thirds of a revolution.

An Ames dial measured the penetration in thousandths of an inch.

[1] Presented at the Annual Meeting, American Ceramic Society, Detroit, Mich., February, 1927. (Refractories Division.)

Apparent Specific Gravity The apparent specific gravity of the test pieces was determined by dividing the solid volume in cubic centimeters into the weight in grams, solid volume being determined as described under "Porosity."

Porosity A modification of the gas-expansion method[2] was used to obtain the porosity values. In this method the volume, V, of air which fills the pores of the test piece is determined by measuring the change in pressure which accompanies a definite increase in its volume. Bulk volume, b, is determined with this apparatus by measuring with the burette the volume of mercury displaced by the test piece. Solid volume is determined by subtracting the pore volume from the bulk volume.

$$\text{Porosity in per cent} = \frac{V}{b} \times 100.$$

Mercury penetrated the large pores, but no appreciable error was introduced because the pieces were weighed before and after the determination and corrections were made for the penetrating mercury.

Crushing Strength Cylinders two inches in thickness and three inches in diameter were crushed on an Olsen hydraulic press of 200,000 pounds capacity. Figure 1 shows a photograph of this apparatus.

To cushion the pressure and aid in making its application more uniform over the face of the cylinder, three layers of heavy cardboard were placed between the cylinder and the pressure caps of the press. Cardboard is more convenient than lead plates, cement, etc., since its accuracy is easily within limits of variation of the test pieces. The average of three pieces was used as the crushing strength value for each set of test pieces.

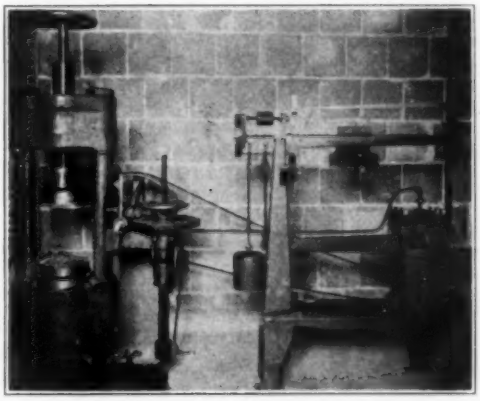

FIG. 1.

Thermal Expansion The coefficients of linear expansion were determined at intervals of approximately 100°C from the room temperature to 850°C, the general softening temperature of the bonds. Figure 2 is a photograph of this apparatus and Fig. 3

[2] A. Ernest MacGee, "Several Gas Expansion Pyrometers," *Jour. Amer. Ceram. Soc.*, 9, 814–22 (1926).

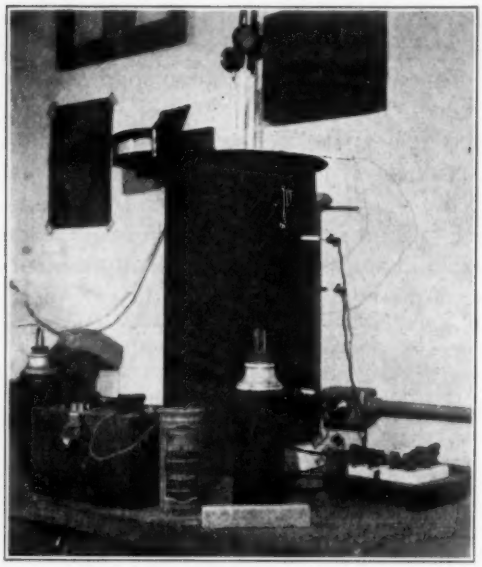

FIG. 2.

is a cross-section which, for simplicity, shows only one rod and test piece. Measurements on three 1- by 1- by 6-inch test pieces were made at one time.

The apparatus consisted, essentially, of a nichrome wire-wound furnace.

The temperature was controlled by means of a 300-ohm rheostat. The actual temperature was determined potentiometrically by means of two thermocouples, the hot junction of the one being at the center of the tops and of the other at the center of the bottoms of the three test pieces. The cold junction temperature was that of melting ice.

The test pieces stood upon fused silica rods imbedded in the Sil-O-Cel clay block at the bottom of the furnace. Fused silica rods extended through the Sil-O-Cel clay furnace cover and rested upon the tops of the respective test pieces. The pinion of an Ames dial rested upon the top of the fused silica rod which extended above the furnace a distance of about ten inches. Thus, the combined movement of the rods and test piece was recorded on the Ames dial calibrated in thousandths of an inch. Readings were estimated to within one-tenth of a division.

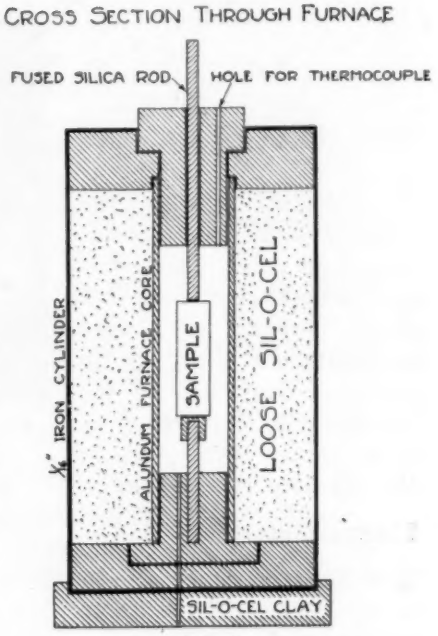

FIG. 3.

The expansion of the apparatus was determined with a well-annealed 1- by 1- by 6-inch bar of fused silica. The expansion of the 6-inch fused silica bar was

calculated according to the values given by Merritt.[3] Thus the expansion of the apparatus was determined by subtracting the value for the 6-inch fused silica bar from the total expansions recorded at the various temperatures. The average of ten closely agreeing series of values was taken as representing the expansion of the apparatus.

The expansion of a test piece was determined by subtracting the expansion of the apparatus from the expansion shown on the dial with the test piece in place. The coefficient of linear expansion was then calculated from the length of the test piece and the amount it expanded when heated above the temperature interval in question, the initial temperature in every case being 30°C. The calculation is as follows:

$$a = \frac{L - l}{l(t - 30)}$$

in which a = coefficient of linear expansion over the interval 30°C to t°C
t = temperature in degrees C
l = length of test piece at 30°C (room temperature)
L = length of test piece at the temperature, t

The rheostat was so regulated as to cause the temperature to rise to 114°C in about 10 minutes. Sufficient resistance was then placed in the circuit to cause the temperature to remain constant at this temperature for 20 minutes, after which the dials were read. The resistance was then decreased sufficiently to cause the temperature to increase to 235°C in about 10 minutes. When this temperature had been maintained for 20 minutes, the dials were read. Readings were thus taken at approximately one hundred-degree intervals up to 844°C. The temperature was held constant for 20 minutes at each interval in order to assure a uniform temperature in the test piece. The furnace temperatures in the different determinations were duplicated to within 10°C.

The coefficient of expansion values given in Table I are the averages of data obtained on six different test pieces, while Table II shows the average of three different test pieces.

Transverse Strength

The 1- by 1- by 4-inch bars used in the porosity tests were employed for this test, the bars being broken over a 3-inch span on a Riehle machine. Modulus of rupture was calculated according to the following formula:

$$M = \frac{3 \times P \times L}{2 \times b \times d^2}$$

in which M = modulus of rupture
P = pressure applied
L = distance between knife edges
b = breadth of test piece
d = depth of test piece

[3] G. E. Merritt, "Thermal Expansion of Fused Quartz," *Jour. Amer. Ceram. Soc.*, 7, 803–808 (1924).

The average of the values for six bars was used as the modulus of rupture.

Modulus of Elasticity

The Riehle machine was also used to determine Young's modulus of elasticity on 1- by 1- by 6-inch bars. The pressure was applied over a 5-inch span. The plane of the lower knife edges was kept constant by keeping the beam balanced. As pressure was applied by screwing down the stirrup or top knife edge, the test piece was bent downward. The pinion of an Ames dial was placed on the stirrup and the amount which the piece deformed under a given pressure was registered on the dial in thousandths of an inch. Young's modulus of elasticity was calculated as follows:

$$E = \frac{m \times L^3}{4 \times S \times b \times d^3}$$

in which E = Young's modulus of elasticity
m = pressure applied
L = distance between knife edges
S = bending of test piece
b = breadth of test piece
d = depth of test piece

The average of the values for six bars was used as the modulus of elasticity.

Mechanical Endurance

Figure 4 shows the apparatus used to determine mechanical endurance. One thousand to 10,000 blows were required to break 1- by 1- by 2-inch test pieces. The test shows the resistance to small repeated mechanical shocks, the resistance being a combination of crushing strength, hardness, elasticity, toughness, etc.

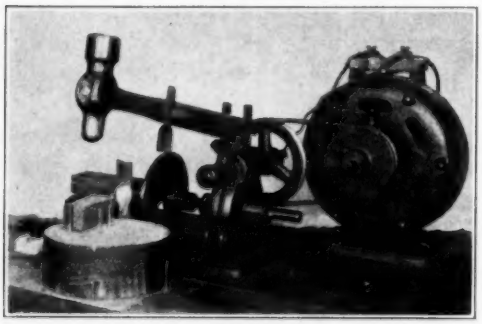

FIG. 4.

The apparatus consisted essentially of a motor and speed reducer with a cam for lifting the hammer. The number of blows was registered on a mechanical counter. When the piece broke the hammer fell far enough for the handle to depress a small lever which threw the switch and stopped the motor. Obviously the apparatus required very little attention.

Mechanical endurance is expressed as the number of blows required to break the test piece.

The hammer weighed about 800 grams and fell three inches, striking about 20 blows per minute, gradually wearing a hole in the test piece.

In order to avoid forming an ever-increasingly large hole, thus minimizing the effect of the blow, the pien end of the hammer was ground to a uniform diameter of $^5/_8$ inch.

Ten layers of ordinary newspaper were placed under the test piece in order to cushion the blow and to help insure a more uniform surface.

If the piece survived 3500 blows, an additional weight of 475 grams was added to the hammer in the form of a steel cap so turned out as to fit the head of the hammer. The average of three pieces was used as the value for mechanical endurance.

Impact Strength The resistance of the test piece to severe mechanical shock was determined in an Olsen impact machine in which a two kilogram weight was dropped successively one, two, three, etc., centimeters until the test piece (1- by 1- by 2-inch) was broken. Ten layers of ordinary newspaper were placed under the test piece. The sum of the blows required to break the piece was taken as the impact strength of the specimen in question, the value of each blow being expressed in terms of momentum as gram centimeters per second per second at the instant of impact.

The calculation is as follows:

(1) $$t = \sqrt{\frac{2d}{g}}$$

in which t = time required for weight to fall
d = distance weight falls
g = gravity constant (980)

(2) $$V = at$$

V = velocity of falling weight
a = acceleration due to gravity (980)
t = time required for weight to fall

(3) $$M = Mv$$

M = momentum at instant of impact
m = weight which falls
v = velocity of weight at time of impact

The average of the values for six test pieces was used as the impact strength.

Heat Shock The resistance of the various test pieces to sudden temperature change is expressed as the percentage decrease in impact strength after a definite heat shock treatment. The heat shock treatment consisted of quenching the test pieces (1 by 1 by 2 inches) in water at room temperature from an electric furnace temperature of 400°C ± 10°C. After quenching, the pieces were allowed to steam in the air for one minute after which they were again placed in the furnace. This alternate heating and cooling was repeated ten times. Following this heat shock treatment, the resistance of the pieces to sudden mechanical shock was determined as described

under "Impact Strength." Knowing the original impact strength of duplicate test pieces, heat shock was calculated as follows:

$$h = \frac{R - r}{R} \times 100$$

in which h = resistance to heat shock
R = impact strength before heat shock
r = " " after " "

The average of the values for three test pieces was used as the heat shock.

Experimental Results

Expansion Values

The values in Table I are the averages of six tests on "regular" bond test pieces designated as *A*, *B*, *C*, *D*, and *E*. All of these test pieces were made with the same percentage of bond and the same abrasive, but with a different bond, used respectively by each company.

TABLE I

AVERAGE COEFFICIENTS OF LINEAR EXPANSION OF THE REGULAR BOND TEST PIECES OVER THE INTERVAL 30°C to *t*°C

Temp. °C	*A* *a*	*B* *a*	*C* *a*	*D* *a*	*E* *a*	*A* *b*	*B* *b*	*C* *b*	*D* *b*	*E* *b*
114	4.7	4.4	4.3	3.8	4.4	3.8	3.5	4.6	4.8	4.1
235	5.5	5.6	5.5	5.1	5.5	5.3	5.0	5.9	5.5	5.5
357	6.4	6.4	6.4	6.0	6.3	6.3	6.0	6.3	6.3	6.3
483	6.7	6.9	6.7	6.4	7.0	6.6	6.5	6.7	6.8	7.0
602	7.0	7.1	7.0	6.8	7.2	6.9	7.0	7.1	7.0	7.4
724	7.3	7.3	7.3	7.2	7.3	7.4	7.2	7.4	7.3	7.7
844	7.5	7.4	7.3	—	7.6	7.7	7.6	7.5	7.5	7.8

Temp. °C	*A* *c*	*B* *c*	*C* *c*	*E* *c*	*A* *d*	*B* *d*	*C* *d*	*D* *d*	*F*
114	4.9	4.6	4.5	4.2	4.4	3.9	4.6	4.2	3.1
235	5.7	5.6	5.7	5.8	5.3	5.0	5.7	5.2	4.9
357	6.7	6.3	6.4	6.4	6.1	5.9	6.3	6.3	6.3
483	7.0	6.9	6.9	7.0	6.6	6.4	6.9	6.8	7.1
602	7.5	7.2	7.2	7.4	6.9	6.7	7.2	6.9	7.5
724	8.0	7.5	7.4	7.7	7.3	6.9	7.4	7.0	8.0
844	8.1	7.7	7.7	7.7	7.7	7.4	7.6	7.4	8.2

NOTE: Values are to be multiplied by 10^{-6}.
a, hard grade; *b*, medium grade; *c*, very soft grade; *d*, medium soft grade
Column *F* shows the values for the expansion of pure artificial corundum. *A*, *B*, *C*, *D*, and *E* indicate the products of different factories.

Table II shows the values for the "special" bond test piece.

TABLE II

AVERAGE COEFFICIENTS OF LINEAR EXPANSION OF THE SPECIAL BOND TEST PIECES OVER THE INTERVAL 30°C TO *t*°C

Temp. °C	*A* *a*	*C* *a*	*D* *a*	*E* *a*	*A* *b*	*B* *b*	*C* *b*	*E* *b*
114	2.4	4.8	4.4	4.0	4.0	4.2	4.4	4.0
235	4.0	5.7	5.6	5.1	5.4	5.4	5.8	5.3
357	5.3	6.1	6.1	6.0	6.1	6.0	6.4	6.3
483	5.9	6.5	6.8	6.5	6.6	7.0	6.7	6.6
602	6.5	6.9	6.9	6.9	6.9	—	7.0	7.1
724	7.0	7.4	7.2	7.3	7.4	—	7.5	7.6
844	7.4	7.6	7.5	7.4	7.6	7.5	7.7	7.6

Temp. °C	*A* *c*	*B* *c*	*C* *c*	*D* *c*	*E* *c*	*F*
114	3.7	4.3	4.9	4.0	4.2	3.5
235	5.1	5.5	5.7	5.2	5.3	4.1
357	6.0	6.1	6.2	6.2	6.1	4.3
483	6.6	6.6	6.6	6.8	6.5	4.5
602	6.8	7.0	7.0	7.1	6.7	4.8
724	7.4	7.6	7.4	7.4	7.1	5.8
844	7.7	7.7	7.6	8.0	7.5	6.0

NOTE: Values are to be multiplied by 10^{-6}.
b, medium; *c*, medium soft; *a*, medium hard
Column *F* shows the expansion of the pure glass special bond made by factory *B*.
A, *B*, *C*, *D*, and *E* indicate the products of different factories.

Some of the expansion data are graphically illustrated in Figs. 5, 6, 7, and 8.

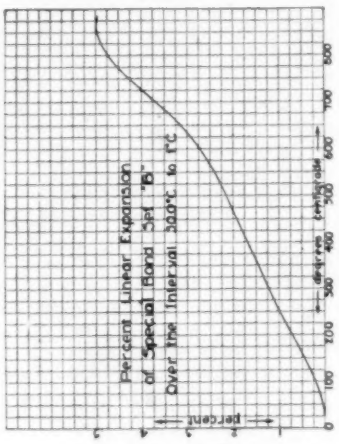

FIG. 5.

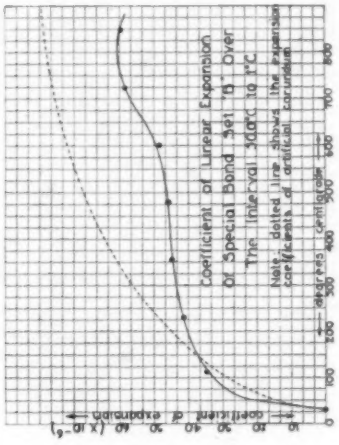
Coefficient of Linear Expansion
of Special Bond Set "B" Over
The Interval 30°C. to t°C
Note: dotted line shows the expansion
coefficients of artificial corundum
degrees centigrade
coefficient of expansion

FIG. 6.

Figures 5 and 6 show the expansion in values for the fused "special" bond without corundum admixture. Figure 8 shows the expansion of this bond (the glass bond only) is decidedly less than that of artificial corundum. The curve, Fig. 6, illustrating the percentage expansion of the "special" bond takes the general shape characteristic of glasses in which a rapid increase in expansion is exhibited in the neighborhood of 700°C.

Figures 7 and 8 show the expansion values for the medium grade regular bond test pieces of *E*. It is noted that the expansion curve for a grinding wheel test piece assumes the general shape of that of artificial corundum rather than that of the bond, the rapid increase in expansion at about 700°C being only slightly perceptible.

It is to be noted from Tables I and II that the expansion of the grinding wheel test pieces is less than that of artificial corundum, the actual expansion decreasing with increasing bond content. In

view of this and the fact that the expansion of the one sample of pure glass bond (special bond *B*) was, generally lower than that of artificial corundum, it seems reasonable to say that the expansion of artificial corundum is greater above 300°C than the regular bonds employed by abrasive manufacturers. Below 300°C, however, the expansion of artificial corundum is, generally, less than that of the present grinding wheel bonds.

TABLE III

AVERAGE VALUES FOR EACH OF THE TWO SETS OF REGULAR BOND TEST PIECES

Set	Grade	Porosity	Apparent sp. gr.	Modulus of rupture	Impact strength	Heat shock	Endurance	Crushing strength	Modulus of elasticity
B Very soft	77.4	27.2	3.84	1400	1.99×10^6	78.5	888	5100	5.2×10^6
C " "	55.3	30.0	3.86	1500	1.75 "	—	1486	5900	6.8 "
D " "	135.1	34.8	—	1000	1.15 "	—	1540	4700	3.3 "
E " "	60.1	28.4	3.85	1700	2.44 "	33.8	2145	—	5.0 "
A Medium	29.8	25.2	3.82	3100	3.73 "	79.6	2606	6500	6.8 "
B "	31.8	23.3	3.61	2400	3.41 "	78.4	1876	8700	8.9 "
C "	37.8	26.6	3.72	2400	2.20 "	—	3381	9600	7.8 "
D "	56.5	28.0	3.73	2200	1.71 "	—	2082	8900	5.6 "
E "	38.0	25.3	3.76	2300	2.66 "	—	2017	—	5.5 "
A Very hard	22.9	25.0	3.51	3000	3.50 "	72.6	4500	5800	5.8 "
B " "	20.6	23.7	3.16	2700	3.54 "	59.0	4343	13000	7.4 "
C " "	20.1	27.5	3.56	2200	2.16 "	—	5154	14100	8.7 "
D " "	22.0	30.0	3.65	2000	1.59 "	—	2602	8600	5.6 "
E " "	21.4	24.5	3.54	2400	2.59 "	—	5744	—	5.6 "
A Medium soft	35.3	—	—	2000	—	—	—	5300	6.7 "
B " "	67.8	23.6	3.76	1600	2.29 "	81.3	1647	5100	6.7 "
C " "	49.2	28.5	3.78	1900	2.59 "	40.7	1881	7900	5.9 "
D " "	88.9	23.3	3.77	1200	2.17 "	65.8	1421	3900	5.8 "
A Medium	55.1	24.6	3.64	1500	1.85 "	70.6	—	6500	
B "	23.9	22.4	3.52	2300	3.70 "	78.0	3118	6900	
C "	46.2	27.1	3.72	1900	3.24 "	63.2	2146	7100	
D "	47.1	22.3	3.55	1900	3.04 "	55.2	2479	8000	
E "	41.0	25.0	3.71	2200	4.30 "	51.9	4600	11100	
A Very hard	15.4	25.6	3.41	2400	2.43 "	63.0	—	7400	
B " "	17.9	24.7	3.31	2400	3.19 "	63.0	4199	10200	
C " "	17.3	24.5	3.40	3100	4.07 "	64.6	4683	12100	
E " "	11.8	21.5	3.37	2900	5.86 "	59.7	5863	13600	
D Medium hard	31.7	24.3	3.36	2800	3.85 "	74.9	3431	11700	

NOTE: *A*, *B*, *C*, *D*, and *E* indicate the products of different factories. Porosity and heat shock are expressed as per cent. Modulus of rupture, crushing strength, and modulus of elasticity are expressed as pounds per square inch. Impact strength is expressed as gram centimeters per second^2. Grade is expressed as thousandths of an inch. Mechanical endurance is expressed as number of blows.

Other Values Table III shows the average values for the various physical properties of the regular bond test pieces. All of these test pieces were made with the same percentage of bond and abrasive but each set was made with a different bond. Figures 9, 10, 11, 12, 13, and 14 graphically illustrate part of these data for the regular bond grinding wheel test pieces. In drawing the curves from these data, the average values of both sets were plotted and the best smooth

curve drawn through the respective points. The curves are drawn in this manner so that one may see at a glance the general effect of increasing the percentages of bond.

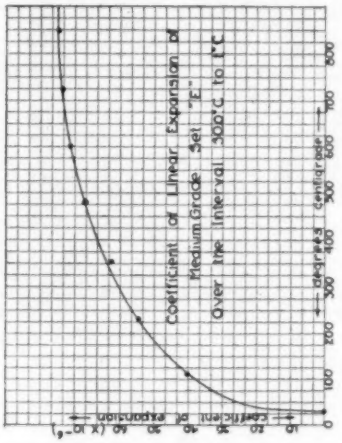
Coefficient of Linear Expansion of
Medium Grade Set "E"
Over the Interval 300°C. to 1°C.
degrees Centigrade
Coefficient of expansion

FIG. 7.

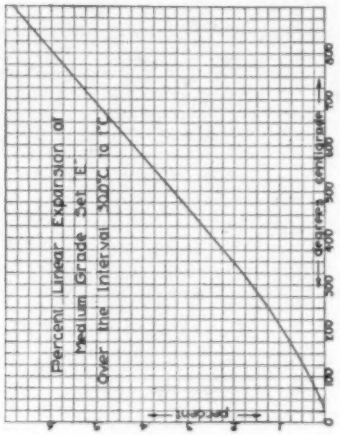

FIG. 8.

Table IV shows the average values obtained for the various physical properties of the "special bond" test pieces. These pieces were made by the puddled process with the same bond and the same percentages of bond and abrasives, the only variable being the difference in plant procedure at the different factories.

TABLE IV
AVERAGE VALUES FOR THE SPECIAL BOND TEST PIECES.

	Set	Grade	Porosity	Apparent sp. gr.	Modulus of rupture	Impact strength	Heat shock	Endurance	Crushing strength	Modulus of elasticity
A	Medium soft	59.8	26.0	3.82	2700	3.26×10^6	73.9	—	6900	7.2×10^6
B	" "	35.2	—	—	3300	3.69 "	83.2	3869	7600	7.4 "
C	" "	56.9	28.1	3.87	2100	2.29 "	47.7	2033	6800	5.4 "
D	" "	62.6	—	—	2100	2.83 "	39.4	1984	7100	6.7 "
E	" "	82.0	27.0	3.70	1500	2.05 "	42.0	3440	9300	—
A	Medium	23.9	21.2	3.52	2800	4.12 "	79.3	—	6800	7.9 "
B	"	28.0	—	—	3400	4.99 "	87.9	6431	10200	8.0 "
C	"	42.4	28.6	3.72	2200	2.18 "	53.3	1770	6600	7.5 "
D	"	40.9	—	—	2500	3.54 "	72.9	2509	8100	—
E	"	10.5	21.5	3.66	3300	5.44 "	69.8	—	16000	6.8 "
A	Medium hard	16.0	21.2	3.40	3100	4.30 "	69.4	—	10700	8.5 "
B	" "	13.0	—	—	3900	6.34 "	84.1	—	13400	7.2 "
C	" "	29.8	26.9	3.55	2600	2.77 "	59.0	4464	8900	9.8 "
D	" "	23.2	—	—	2800	4.29 "	66.0	3587	9500	11.3 "
E	" "	8.5	18.3	3.23	4200	7.00 "	71.5	—	13200	7.4 "
	Pure glass special bond *B*				2500	1.45 "	—	2600	—	4.0 "

NOTE: Porosity and heat shock are expressed as per cent. Modulus of rupture, crushing strength, and modulus of elasticity are expressed as pounds per square inch. Impact strength is expressed as gram centimeters per second^2.

Grade is expressed as thousandths of an inch.

Mechanical endurance is expressed as number of blows.

A, *B*, *C*, *D*, and *E* indicate the products of different factories.

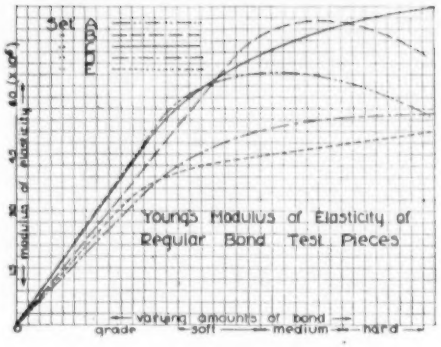

FIG. 9.

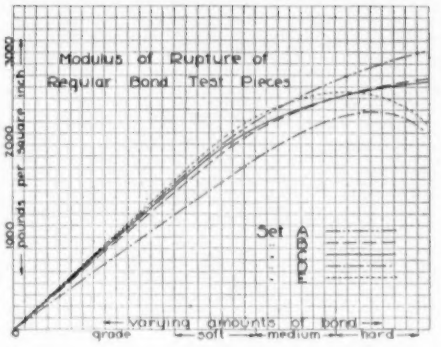

FIG. 11.

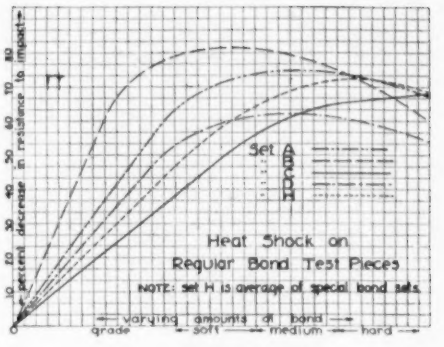
Heat Shock on
Regular Bond Test Pieces
NOTE: set H is average of special bond sets
percent decrease in resistance to impact
Set
varying amounts of bond
grade soft medium hard

FIG. 13.

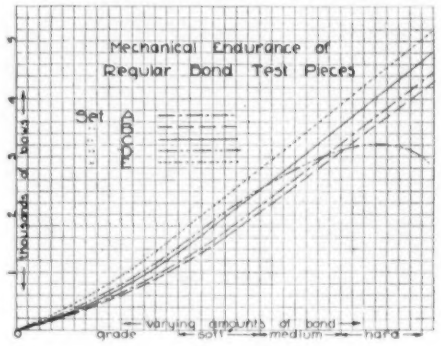

FIG. 10.

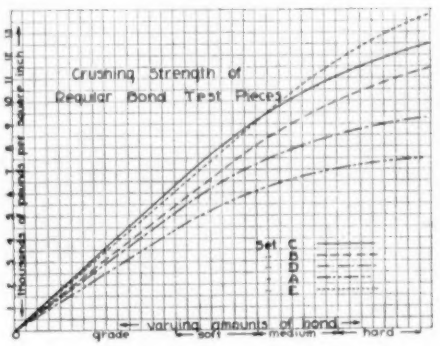

FIG. 12.

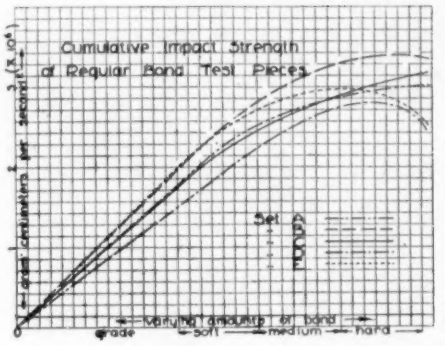

FIG. 14.

Summary

(1) The physical properties which are characteristic of soft, medium, and hard grade artificial aluminous puddled grinding wheels are as shown in Table V.

TABLE V

Characteristic Physical Properties of Soft, Medium, and Hard Grade Regular Bond Puddled Artificial Aluminous Grinding Wheels

	Very soft	Medium soft	Medium	Hard
Grade	81	60	41	19
Porosity	30	28	25	24
Apparent specific gravity	3.85	3.77	3.67	3.43
Modulus of rupture	1500	1700	2300	2600
Impact strength	1.86×10^6	2.35×10^6	3.14×10^6	3.42×10^6
Heat shock	78	73	68	62
Mechanical endurance	1510	1650	2800	4930
Crushing strength	5200	6100	8100	11,300
Modulus of elasticity	4.1×10^5	6.2×10^5	6.9×10^5	6.6×10^5

Coefficient of Expansion	
Very soft	7.7×10^{-6}
Medium	7.4 " "
Hard	7.4 " "

NOTE: Coefficient of linear expansion over the interval 30°C to 724°C. Porosity and heat shock are expressed as per cent. Modulus of rupture, crushing strength, and modulus of elasticity are expressed as pounds per square inch. Impact strength is expressed as gram centimeters per second². Grade is expressed as thousandths of an inch. Mechanical endurance is expressed as number of blows.

(2) Porosity, specific gravity, elasticity, and thermal expansion decrease with increasing percentages of bond and resulting hardness of grade.

(3) Resistance to heat shock, impact strength, modulus of rupture, crushing strength, and mechanical endurance increase with increasing percentages of bond and resulting hardness of grade.

(4) Above about 300°C the expansion of grinding wheel bonds is less than that of artificial corundum. Although the expansions approach equality below 300°C, the expansion of the bonds is greater than that of artificial corundum below this temperature.

(5) Using the same bond and the same percentages of bond and abrasive, the physical properties of grinding wheels from different factories will vary considerably. This is doubtless due to the fact that the routine procedure at no two plants is exactly alike.

WINNING OF MISSOURI DIASPORE, BURLEY, AND FLINT CLAYS[1]

By C. R. Forbes[2]

ABSTRACT

The process of mining Missouri diaspore, burley, and flint clays is described in careful detail.

Introduction

In the State of Missouri, about one hundred miles southwest of the city of St. Louis, (Fig. 1) are found what, so far, constitute the most important deposits of diaspore clay in the United States. Associated with the diaspore clay are burley and flint fire clays. For many years the flint clay was mined in this district and the burley and diaspore clays were discarded as waste and were referred to as "sandy clays." About ten years ago the high alumina content of these "sandy clays" was discovered and since then there has been an increasing demand for them in the manufacture of high alumina or "super" refractories.

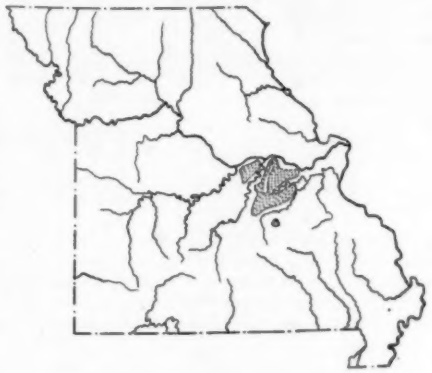

Fig. 1.—Clay district outlined from map prepared by Missouri Bureau of Geology and Mines.

Production

The production of the district for the year 1926, according to figures of the Missouri Bureau of Geology and Mines, and the U. S. Bureau of Mines, was 18,400 tons of diaspore clay and 93,500 tons of flint clay. As these figures do not include production by companies using the material in their own plants, it is probable that the actual tonnage produced was much greater. The production comes from a number of small operations, very few pits producing more than forty or fifty tons per day.

Geology and Occurrence

The deposits are of the sink-hole type and are found in sandstone of the Cherokee formation at the base of the Pennsylvanian series.

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February 1928. (Refractories Division.) Received January 3, 1928.

[2] Professor of Mining, Missouri School of Mines and Metallurgy.

Underlying the Cherokee formation are magnesian limestones of Ordovician age. The sinks have resulted from the formation of caverns or cavities in these soluble underlying rocks which, in some instances, have been filled with sandstone and clay. It is interesting to note in this connection that deposits of coal and iron ore also occur under similar conditions in this part of Missouri.

The accompanying cross-section (Fig. 2) illustrates the occurrence of the clays and sandstone in a typical deposit. In horizontal outline this deposit is roughly circular.

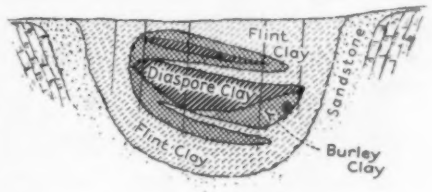

FIG. 2.—Cross-section through clay deposit.

The sandstone lining the walls of the sink is called a "rim-rock." It often outcrops and is of great assistance to the prospector in locating new deposits, and is also of aid in de-limiting a deposit when found. An outcropping sandstone "rim" is shown in Fig. 3.

The deposits vary in size from small pockets containing a few tons to larger ones containing 100,000 tons or more. An average size pit would probably be about 100 feet long, 75 feet wide, and 40 or 50 feet deep. Such a pit might contain 20,000 or 25,000 tons of clay, 50 to 75% of which might be flint clay, the remainder being burley and diaspore clay. It is very difficult, however, to give any general estimate as to the average size or percentage of different clays in these deposits. In many deposits flint clay constitutes 100% of the total tonnage; in fact, it is estimated that of the 400 known deposits, only about 100 contain diaspore clay. Some deposits contain burley and flint clays with no diaspore, while in a few deposits it constitutes the greatest part of the tonnage.

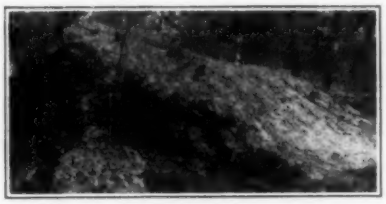

FIG. 3.—Dipping sandstone rim rock marking clay deposit.

Character and Uses of Clays

The chemical composition and softening points of four typical clays from this district are given in Table I.

It will be noted from a study of these analyses that the chief difference in these clays is in their alumina and silica content. The clays intermediate in alumina content between flint fire clay and diaspore clay are known in the district as burley clays. The name was given by the miners to those clays containing oolites of the mineral diaspore

(Al_2O_3–H_2O), which were known to them as "burls." Several grades of this clay are found varying from the rough or "burley" flint clay to an open textured material approaching diaspore clay in appearance and chemical composition. There is no well established line between the different grades of clay, but an arbitrary classification sometimes used is as follows: diaspore clay material containing 70% or more alumina; first grade burley clay material containing from 60% to 70% alumina; second grade burley clay material containing from 50% to 60% alumina.

TABLE I

ANALYSES OF TYPICAL CLAYS FROM DISTRICT[3]

	Flint fire clay	Second grade burley clay	First grade burley clay	Diaspore clay
Silica	43.58	30.38	16.37	6.56
Alumina	38.45	52.25	63 82	72.72
Ferric oxide	1.36	2.01	1.84	2.37
Lime	0.14	0.08	0.22	0.00
Magnesia	0.39	0.08	0.08	0.00
Titania	2.45	2.10	3.15	3.65
Soda	0.55	0.30	0.43	0.57
Potash	0.13	0.14	0.57	0.43
Ignition loss	13.54	13.11	13.91	13.88
Total	100.59	100.45	100.39	100.18
Softening Point	Cone 34	Cone 36 to 37	Cone 37 to 38	Cone 40

Uses The diaspore clay, which derives its name from the mineral diaspore, is an extremely valuable and useful material for the manufacture of high alumina or "super" refractories. These refractories have been found to be exceptionally well suited to certain severe uses, such as linings for cement and lime kilns, glass tank blocks, boiler settings, and the like, and their perfection by ceramic engineers has been a distinct contribution to American industry. A small tonnage of diaspore clay is used annually for the manufacture of abrasives. For this purpose it should contain less than 7% silica, but a high percentage of iron is not objectionable, and some high iron, abrasive grade, "red diaspore" is being mined in the district.

The burley clays from this district are being used more and more for the manufacture of different grades of high alumina refractories and the flint fire clay is used chiefly in the manufacture of high grade fire brick.

Prospecting

Most of the present known clay deposits have been found from surface croppings, but in some instances the exposure of rim rocks has led to the discovery of hidden deposits. Prospectors in the field follow

[3] Analyses from Missouri School of Mines and Metallurgy, *Bull.*, No. 2, Vol. 8 (Technical Series).

much the same methods used for years in connection with metalliferous deposits, searching the valleys and stream beds for pieces of "float." Many pits have been found in this way by tracing the float material to its source, and in some cases pits have been found a mile or more from the point where the first indications were noted.

Drilling After a deposit has been found, the work of drilling to determine the character and extent of the clay is commenced. If a "rim rock" is visible, the first hole will be started as nearly as possible in the center of the pit. If no "rim rock" is visible, the first hole is located in the vicinity of the best croppings.

FIG. 4.—Clay auger.

Before starting a drill hole, it is necessary to dig through the overburden down to the clay. If the overburden is deep, this may prove quite a task, but usually a pit 3 or 4 feet deep, will find solid clay. A wooden box made of 1- by 4-inch lumber is then set on the clay. The dirt is packed around it and drilling is started inside the box.

Auger Drilling is done almost entirely with augers welded onto the ends of short pieces of $^3/_8$-inch pipe (Fig. 4). Additional lengths of pipe are added as necessary, and a T on the end with two short pieces of pipe serves as a handle. The best augers are made by local blacksmiths, and have been found to be particularly suited to this work. They are made by twisting a piece of $1^1/_4$- by $^5/_{16}$-inch spring steel giving it about $3^1/_2$ complete turns for 12 inches in length. The cutting edge is drawn out to about 2 inches in length and is filed to shape. The bits are not tempered hard, as they are resharpened in the field by filing. Smaller augers are sometimes used in drilling very deep holes. A well-made auger may be used for drilling several hundred feet of holes in clay, but if sandstone or "iron band" (Fig. 5) is encountered it may be hopelessly dulled in a few minutes of drilling.

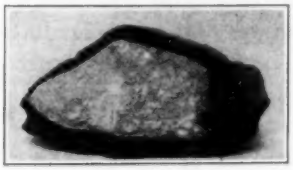

FIG. 5.—Iron-band diaspore. The outer shell is hematite and the light-colored material is diaspore clay.

Speed of Drilling The speed of drilling varies greatly with the character of the clay and depth of holes. A skilled workman can drill a 20-foot hole in flint clay in 5 hours. In diaspore clay he can drill about the same, but in burley his progress may be only 15 feet. If many streaks of iron-band are encountered, a day's work may produce only 4 or 5 feet in shallow holes. A chisel bit is used to chop through this material, and is followed by the auger. In drilling beyond a depth of 30 feet, a speed of 6 to 8 feet per day is good work for two men.

Holes have been drilled to depths of 90 to 100 feet in prospecting some of the larger deposits. In drilling deep holes, a gin pole with a pulley and a steel barrel hoop near the top is provided. A rope over the pulley and attached to the rods by a sliding link, is used to pull the rods out of the hole, and the hoop serves to hold them as they are uncoupled.

Collecting the Sample The sample is obtained by cleaning the clay from the spirals of the auger with the hand. The auger must be pulled from the hole at least every 4 to 8 inches in shallow holes, and every 3 or 4 inches in deep holes. As long as the cuttings appear to be of the same kind of material, they are accumulated in one sample. A skilled driller can usually tell by the feel of the auger when any change takes place in the hole, and he governs his sample accordingly. The abrasive quality of the high alumina clays is made use of in identifying them. Cuttings from high grade diaspore clay show a very dark color when removed from the auger, while cuttings from a lower grade material may be colored only slightly. The blade of a knife is also used for this test. A very small amount of water is used in drilling, an excess being objectionable, as it greatly interferes with the accuracy of sampling and speed of drilling. In holes which carry much water, the sample can only be obtained by pumping the cuttings from the hole. This is done by inserting a pipe with a ball valve near the bottom, and pumping it up and down. The sludge is discharged from the pipe on to a sack or blanket to recover the cuttings. A better method would be to pump the material into a container and allow the clay to settle.

Diamond drills have been used for prospecting some deposits. Most of them, however, are too small and the holes too shallow to justify the use of any power drill. The cost of supplying water to diamond drills would also be excessive in many instances where no water is available within a reasonable distance.

The samples obtained from drilling are sent to the chemist for analysis. Complete analyses with fusion tests should be run on a few samples from each deposit in order to make sure that the clays contain no alkalis or other deleterious substances, and to determine the total percentage of all impurities, from which it is afterwards possible to estimate the alumina percentage in other samples, simply by determining silica and loss on ignition. This may be illustrated by referring to the analysis of the diaspore clay in Table I. If we had assumed that the impurities in this sample totaled 6% and ignition loss was found to be 13.9%, and silica 6.6%, the alumina content could have been calculated by subtracting the sum of impurities, silica and ignition loss from 100%, giving 73.5% alumina, which is close enough for the estimation of tonnage.

Computation of Tonnage The computation of tonnage from drill records is based on a specific gravity factor of 16 cu. ft. to the ton although some contracts are drawn stipulating that 20 cu. ft. shall be used for estimation of tonnage. To determine accurately the tonnage of the different grades of diaspore and burley clays is quite difficult, and requires that many analyses be made, as these materials grade imperceptibly into each other, and very often only the combined tonnage is estimated.

The thoroughness with which a prospect is drilled will depend on the purpose of the drilling. If it is to determine tonnage that is to be paid for in the ground, the drilling will need to be done much more thoroughly and accurately than if it is simply to determine whether or not the pit is worth developing. In the latter case, enough drilling should be done to determine the shape and extent of the deposit in order to plan the best method of opening the pit with regard to stripping, drainage, haulage, and height of faces to be used in mining. Some pits have been opened without sufficient preliminary drilling, and the stripping has been piled in a location where it had to be moved a second time.

For determining tonnage accurately, holes should not be spaced over 30 feet apart, and a 20-foot interval is desirable. It sometimes happens that "horses" of flint clay extend through the center of a deposit, and unless the holes are drilled quite close together they might easily be overlooked. Even with this close spacing of drill holes the final estimate may be more or less inaccurate. Some deposits have produced much more burley and diaspore clay than estimated from the cuttings, because in mining it was possible to sort the clay much more closely than in sampling. Dilution of the cuttings by spalls of flint clay from the sides of the drill holes may also contribute to this inaccuracy. In most instances the actual tonnage mined will probably exceed the original estimate so that the error is on the side of safety.

Leasing and Royalties

Most of the deposits in this district have been acquired by leasing. The royalties paid to owners depend upon the distance from the railroad and size of the deposits. A common rate, in the past, has been 50 cents per ton for diaspore and 30 cents for burley clay for deposits 10 miles or so from the railroad. The common form of lease calls for a minimum advance royalty of $100 per year, and the term of leases varies from 5 to 20 years.

A few years ago many deposits were leased at much lower figures, but at the present time most of the farm owners are more or less familiar with the clay situation, and demand higher royalties. Where

clay is purchased outright in the ground, the prices are somewhat lower than when acquired by leasing.

Mining

The mining of the diaspore, burley, and flint clays in these small deposits is a comparatively simple operation. It is all small scale work; a production of as much as 100 tons a day is unusual, and more often only 40 or 50 tons are produced per day from one pit.

Stripping The first step in the mining of any of these deposits is stripping. The brush and stumps are first removed, and then the overburden. On small pits teams and scrapers are used (Fig. 6). The 3-horse fresno is far superior to the ordinary slip for this work. Caterpillar tractors with fresnos are, of course, much more economical, but the initial investment may not be justified for the small operator. Stripping costs are difficult to give as there are so many variable conditions affecting them. At one pit 3000 yards were removed an average distance of 150 feet with 3 horse fresnos at a cost of 60 cents per yard. The cost of driver and 3 horses was 80 cents per hour. No doubt this work could have been done more cheaply with tractors. This stripping was mostly red clay and soil, and was not especially difficult. Plowing was done for the most part with two horses. The average depth was about 3 feet. It is very desirable to strip the entire deposit as quickly as possible after opening it up. At any rate stripping should be kept at least 20 feet back from a working face, and a ditch should be kept in the clay between the stripping and the working face to prevent water from running over the face.

FIG. 6 —View of clay deposit. Overburden is being removed. Piles of sorted clay in foreground.

Open Face After the stripping has been carried back a sufficient distance, actual mining of the clay is begun. If the pit is a hillside deposit, it may be possible to open it up by extending the face horizontally into the hillside. If the hill rises steeply a suitable working face will soon be obtained. Until the face reaches a height of several feet the progress is very slow, and the cost excessive.

Blasting The clay is broken by the use of black powder or dynamite, in holes drilled with augers (Fig. 7). Black powder, on account of its slow heaving effect is best suited to this work, but where holes carry much water, a low grade dynamite must be used. The following examples of actual blasts are more or less typical: A 15-foot hole in diaspore and burley clay, located 8 feet from the face on top and with 12-foot burden on the bottom was sprung first with 1 stick of 40% dynamite and then with 4 sticks. The hole was loaded with 25 pounds of FF black powder which broke more than 100 tons of clay. A 22-foot hole in flint clay, located 8 feet from the face on top and with a 15-foot burden on the bottom was sprung with 1 stick of dynamite, followed by a second springing charge of 8 sticks. This hole was loaded with 50 pounds of black powder which broke more than 350 tons of clay. With black powder at 10 cents per pound and dynamite at 20 cents, the explosive cost in the first case was about 3 cents per ton and in the second case $1^1/_2$ cents per ton. Although diaspore clay is somewhat more difficult to break than flint clay, the difference between the two holes was due more to the height of face than to difference in the clays.

FIG. 7.—Drilling blast hole for breaking 22-foot face of flint clay.

If the deposit must be entered by a slope, it may be necessary to cut through the sandstone rim for the run-way. A grade of 15% on the run-way is desirable, but more often this grade is 25% or more. The height of bench to be worked will depend on several factors: the topography, the total thickness of the clay, the thickness of various seams of burley or diaspore clay, and drainage conditions are all factors affecting the height of bench. From the standpoint of safety and efficient blasting a face approximately 15 feet high is desirable.

Sorting Sorting is the most important part of the clay mining operation (Fig. 6). In some pits where the different grades of clay occur in thick seams, it may not be so difficult, but in most pits the gradation between diaspore, burley, and flint is gradual. A single boulder may contain four different grades of clay: *i.e.* diaspore, first grade burley, second grade burley, and flint. To sort such clay properly requires that these boulders be broken by picks, or gads and the various

kinds of clays separated. This work requires very careful supervision, and a foreman who is not interested can cause a great loss to the operator by permitting careless work. Some men develop into good sorters, and the skill with which they can detect the different grades of clay is really quite remarkable. To the uninitiated the difference in appearance between first grade bu.ley and diaspore or between the two grades of burley is difficult to recognize.

The use of any system of mechanical loading is obviously out of the question in mining these clays on account of the careful sorting required.

Hoisting and Pumping

For working the lower level of a pit, it is usually necessary to install hoisting equipment. A swinging boom derrick (Fig. 8) is erected near the edge of the pit, and a small geared hoist driven by a gasoline engine is used to hoist the dump-bottom boxes. These boxes hold about a ton of clay and are dumped direct into trucks or wagons. Two men are required to operate this equipment, one to run the hoist and a "flagman" to signal the hoistman, control the movement of the boom, and dump the box. Where a pit is not self draining, it is necessary to install a pump. Small centrifugal pumps driven by gasoline engines are used in this work. Where topographical conditions permit, syphons are used as long as possible. Pumping and hoisting present no difficult problems, but nevertheless add materially to the cost of production.

FIG. 8.—Derrick used in hoisting clay from deep pit.

Cost of Mining

The cost of drilling, blasting, sorting, and loading onto trucks in the pit, varies from 30 cents to $1.00 or more per ton, with a wage scale of 30 cents per hour for common labor and 35 cents for sorters. The lower figure obtains in pits producing only flint fire clay where no sorting is required, and where all other conditions are favorable. The higher costs obtain where clays are badly mixed and other unfavorable conditions prevail. In narrow, deep pits where hoisting and pumping are necessary, the cost may be greatly increased. Also the necessity of handling waste may greatly increase the total cost. Flint clay may have to be thrown on the dump, if too far from the railroad. The total cost of production due to stripping, mining, hoisting, pumping, and hauling waste, may amount to $2.00 or $3.00 per ton, under the most adverse conditions.

Haulage

For hauling to the railroad one-ton trucks, loaded with two tons or more, are almost universally used. These trucks stand up remarkably well under this severe service. Hauling has been contracted on long hauls (over 10 miles) at from 15 to 20 cents per ton mile on fairly good dirt and gravel roads. Where these low figures prevail, the contracts are usually to individuals who own and operate their own trucks. Company account hauling over fair roads can be done for 25 cents per ton mile under favorable conditions.

Team hauling still prevails in certain localities where roads are too bad for trucks. A good "clay team" can haul loads of 5500 pounds on level roads, and the contract price varies from 30 to 50 cents per ton mile. In one instance the contract price on a 4-mile haul was $1.20 per ton. A good team made two trips per day hauling 5500 pounds each trip, representing an earning of $6.60 for the day.

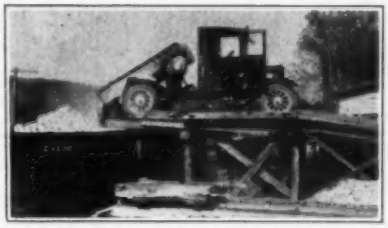

FIG. 9.—Dump truck unloading clay into open car.

Dump trucks afford considerable saving in unloading, especially into open cars (Fig. 9). Much of the clay is shipped in box cars, and it is possible to dump these small trucks directly into them (Fig. 10). It is, of course, necessary to shovel the clay back into the car. One man can shovel back 40 tons into a car in 10 hours, if his loads are properly distributed. The extra cost of loading into box cars as compared to open cars when using dump trucks is approximately 10 cents per ton. In many places dump trucks are not used, and the clay is shoveled from the trucks into the cars at an increased cost of 15 to 20 cents per ton as compared to dump trucks.

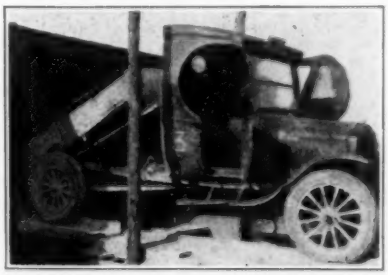

FIG. 10.—Dump truck unloading into box car.

Marketing

The most important problem of the clay producer is marketing his product. In a mixed pit he may produce diaspore, two grades of burley and flint clay, and it is quite important for economical operation to be able to dispose of all the different grades as mined. Flint clay is quite plentiful, and the price varies from $1.35 to $2.00 per ton, f.o.b.

cars, depending on the quality and size. At pits located over four or five miles from the railroad, it is usually necessary to waste this material.

The price of first grade burley varies from $2.50 to $4.50 per ton, and second grade burley from $1.75 to $2.50 per ton. Diaspore is sold at from $5.00 to $8.00 per ton, depending upon the quality of the clay and size of the order.

Future of the District

Because of the nature of the deposits it is very difficult to make any estimate regarding the reserve tonnage of the different clays. The total tonnage of high grade diaspore has been variously estimated at from 750,000 to 1,500,000 tons. There is a considerable tonnage of high iron burley and diaspore clay that, as yet, is not commercially available. A practical method of separating the iron from the clay would add materially to the ore reserves. Burley clay is much more plentiful than diaspore, and there is undoubtedly a large reserve tonnage of this material. Flint fire clay is abundant, but on account of the low price can only be mined, at present, from deposits close to the railroad.

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CERAMIC ABSTRACTS

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Abrasives

Grinding wheels. Simplified Practice Recommendation No. 45. U. S. Dept. of Commerce, 1927.—Twelve types of grinding wheels under the simplified practice acceptance are described. These are representative of practically all grinding machines. This classification of grinding wheels will greatly simplify the stocking of wheels wherever a quantity is kept on hand, and it will also enable the user to accurately order a grinding wheel by giving the type number and the complete dimensions necessary to construct such a wheel, as designated by the cross-section of that type. R. A. H.

Manufacture of artificial grinding wheels. WM. A. FORBES. *Amer. Iron Steel Inst.*, Advance Paper N. Y. Meeting, pp. 83–84 (1927).—The operation required on a large scale was to finish, by grinding, the ends of manganese steel track pieces, such as railroad crossings, frogs, and switches. The wheel is rotated (wet) at a speed of 525 r. p. m. with a pendulous oscillating movement across the end of the rail, removing at times as much as $^3/_4$ in. of metal. The purchase of commercial abrasive was found too expensive; discarded stubs containing alundum, Carborundum, etc., were therefore made up into wheels. The stubs were crushed in a pug mill, and were sieved through various meshes, the clay bond being blown away by air. Wheels were made of this material dry-mixed with cement, and, after setting somewhat, were submerged in water 10–12 days. They were permitted to age as long as possible before use. These wheels

gave good service and have now been replaced only in the small sizes by rubber-bonded wheels. The rubber bond is burnt out of the wheel remnants. The result is said to be a 100% abrasive, resistant to the temperature encountered, and as good as any purchasable from abrasive manufacturers. H.H.S.

Grain depth of cut explained. GEORGE I. ALDEN. *Abrasive Ind.*, **9** [1], 9–12 (1928). —The operation of abrasive wheels in machine grinding is outlined. Correct grain depth of cut determines successful performance of the wheel and is readily seen by the fact that increased production is possible without increasing the depth of cut, by increasing the radial depth of cut and at the same time diminishing the work speed less than the radial depth is increased. P.F.C.

Abrasive engineering progress. ANON. *Abrasive Ind.*, **9** [1], 17 (1928).—The newer developments in the industry are discussed and consist of hydraulic feeds on the surface grinding machines, improvements on the disk grinding machines, self-contained cutter sharpener within machine, ball bearing spindles for knife grinders, heavy duty grinders, and safety shields for grinders. P.F.C.

Care of diamonds. ANON. *Abrasive Ind.*, **9** [1], 17 (1928).—Overheating the diamond is offered as an explanation for one of the principal troubles in their use for grinding wheel truing. Causes are due to abnormal cuts, too rapid feed across the wheel face, use of a stone worn flat, and attempting to true the wheel with insufficient or no water supply. It is possible to bring a diamond to a red heat even under a water spray at which time it will expand the same as any other material. Although the diamond in itself is uninjured by the heat, an enormous pressure is set up against the diamond setting. The metal setting does not heat or expand as readily as the diamond and hence will not relieve the pressure set up by the hotter diamond. Often overheating will cause the diamond to become loose in its setting, preventing its proper operation, and giving rise to the danger of pulling the diamond from its setting and losing it. The best policy to follow is to return the worn diamond to a reliable diamond dealer for inspection and resetting. P.F.C.

PATENT

Method of making abrasive article. DUANE E. WEBSTER. U. S. 1,655,396, Jan. 3, 1928. The method of making an abrasive article which comprises intimately incorporating in a mixture of abrasive grains, a vulcanizable compound and sulphur, an agent capable of modifying the properties of the compound to render it more resistant to heat changes, and thereafter shaping and vulcanizing the article.

Art

Faiences Stanniferes of Jean Gauguin. RENE CHAVANCE. *Art et Dec.*, **31** [310], 101 (1927).—In the spring of 1926 an exchange of ceramic pieces took place between the National Manufacture of Sèvres and the Danish Manufacture of "Bing and Groendahl" which allowed M. Gensol to exhibit in Denmark while Jean Gauguin came to France. Gauguin's mother being of Danish origin, he embraced the country of his mother. His primitive nature could not accustom itself to the delicate handling of porcelain, and therefore he conceived the idea of using sagger clay, adding some fired clay and grog, minimizing the shrinkage and thereby enabling him to build pieces of sizable dimensions. His attention was drawn toward the clays just recently introduced in the manufacture of Sèvres which is more plastic and matures at a lower temperature than the clays formerly used. Using polychrome glazes on biscuit, in 3 months he modeled 16 pieces of importance, 13 of which were groups of figures, and 3 large bowls now the property of the Sèvres Museum. This exhibition shows signs of hasty work, no peaceful cadence as in his "Adam and Eve." On the contrary there is a turbulent restlessness in the modeling of the animals who seem ready to leap into action.

The design is not always good and anatomically much can be criticized, but in their grotesqueness and deformities there is a strength unaccountable. He is essentially a decorator and his sculptural masses hold together in a satisfying way. M.G.W.

Exhibit of decorative arts at Leipzig. RICHARD GRAUL. *Art et Dec.*, **31** [310], 101 (1927).—Interesting review of international decorative modern art organized by Museum of Leipzig. Collection of special interest to the manufacturer, in the modern spirit of art, not inspired by the classic, but inspired by modern conditions and modern living. All these peoples hold their individuality and have a common feeling and tendency, no matter how different their temperaments and tastes. Worthy of note, the reception room designed by A. Bruns Paul, with numerous electric fixtures of geometrical design in harmony with furniture of simple construction. Large glass windows sober in color, yet brilliant, the whole forming an apartment of austere taste. The Austrian room held Mr. Hoffman's large windows, representing the Austrian Bazaar. Czechoslovakia designs brilliant cubist forms. Belgian, Italian, and Swedish movements are all modern. France excels in the manufacture of glass paste. The perfection of Lalique is shown in his electric fixtures. England follows Korean and Japanese art in stoneware of note. Potteries and glassware pleasing in shape are too conservative for modern taste. Holland's colored glass is unusual. Belgium distinguishes itself by its "faience of Persian type." Denmark's "Bing and Groendahl" and "Gauguin" potteries are all classic in their line. Illustrated. M.G.W.

Modern decorative art in Paris. A. R. MACDOUGALL. *Arts and Dec.*, **28** [2], 58 (1927).—One of the latest contributions is the drawing room gardens by Raoul Dufy, Paris artist. With the aid of Llorens Artigas, Spanish ceramist, he created and decorated miniature gardens like scale models of larger enchanted gardens, delighting the eye and the imagination. E.B.H.

Modern life in an old Tuscany villa. MARY F. ROBERTS. *Arts and Dec.*, **28** [3], 33–36 (1928).—This 13th Century stucco villa was built by Tuscan craftsmen at Fiesole, on the Arno. During reconstruction, chimneys of miraculous beauty were found under cement. The walls are a weathered plaster, of no one tone, and the fireplace an old Italian stone piece richly ornamented. A little wafer tray on the table in the library is an interesting piece of early majolica. Singularly beautiful floors are polished brown brick, centuries old. E.B.H.

Picturesque castle in Florida. LUCILE QUINN. *Arts and Dec.*, **28** [3], 45–47 (1928). —In the home of Tom Bryan of Fla. the rough stucco walls of the tower entrance are a coral tinted buff, which is mauve in the shadows cast by the roof of ancient vermillion tiles. E.B.H.

Spain inspires California architect. D. DEM. LUNLEA. *Arts and Dec.*, **28** [3], 50 (1928).—The Thorpe home in Hollywood uses a soft texture stucco with touches of terra cotta where heavy roof tile forms an interesting skyline. The dining room walls, also of soft texture, burnt ivory tint, hold treasured tile from Europe and receive added warmth from the terra cotta floors of an unusually light salmon tint. E.B.H.

Mexican pottery. ANON. *Design*, **29** [8], 141 (1928).—Illustration of Mexican pottery of 1830 now in Metropolitan Museum of Art. E.B.H.

Jacobite glasses in Brooklyn Museum. EDITH H. WALTON. *Int. Studio*, **89** [368], 63–66 (1928).—The Leckie collection in the Brooklyn Museum includes 19 Jacobite drinking glasses dating from 1710 to 1750, 22 Stuart rose glasses, and several more rare but less glamorous Williamite or Orange glasses, used by anti-Jacobites. The first have baluster, plain, and silvery air twist stems made by elongating air bubbles and twisting them into spiral air threads. Old Pretender pieces (none in collection) are inscribed with Jacobite hymns and the crowned cipher of the J. R., have drawn bowls and an elongated air tear. There are two Young Pretender portrait glasses with

mottoes, one with the rose and one with the three Prince of Wales feathers. Cycle Club glasses are more common bearing the emblems, rose with two buds, oak leaf, star, and word "Fiat." Jacobite glasses with engraving underneath the foot, for partial concealment, are rare. Cut stems and those containing opaque white twists of glass were not general until after the middle of the century. Thistle indicates possession by a Scotch family. E.B.H.

Some coloring agents in glasses and glazes. JACKSON. Brit. Scientific Instrument Research Assn.; reprinted in *Amer. Glass Rev.*, **47** [7], 15; [8], 17; [9], 15 (1927).—Results obtained by the use of copper and iron compounds as coloring materials are described in considerable detail. These two were chosen because it was believed that in their mode of action as coloring agents, they illustrate fairly completely the action portrayed by other materials of the same nature. Copper produces reds, browns, greens, blues, purple, yellows, and blacks. Some of the colors are well distinguished in transmitted light, others in reflected light. These effects are obtained by the use of either compounds of copper or else metallic copper, in which case the former is used; the chief sources are cuprous and cupric oxides. Examples of the use of cuprous oxide as a coloring agent are found dating back to the 18th Dynasty in producing the brilliant scarlet Egyptian glasses. A microscopic examination of the glass showed the coloring to be due to crystals of cuprous exide. A chemical analysis showed that the glass was an ordinary lead glass of approximately 30% lead oxide and the quantity of cuprous oxide varied from 8 to 10%. When attempts to reproduce this glass were made, very often yellow crystals were noted in parts of the glass and were identified as due to the yellow or least common form of crystalline cuprous oxide. The red form of cuprous oxide is formed by heating copper in a limited supply of air. The red oxide can be produced by adding to a solution of glucose, a solution of copper sulphate and then adding caustic potash to the mixture. On heating, the clear blue solution is obtained, reduction of cupric oxide by glucose occurs, with the resulting precipitation of red cuprous oxide. As heating is started, it is generally possible to observe the formation of a yellow precipitate mingled with the red. These colors can be more readily seen when Fehling's solution is used, which is made up of copper sulphate, Rochelle salt and caustic potash, and is a clear blue solution. By pouring a small amount of glucose solution into a large amount of boiling Fehling solution, the red oxide is formed. If the reverse or the pouring of a small amount of Fehling solution into a large amount of boiling glucose solution, then the yellow form is produced. If this yellow form is heated to 350°C, it is completely freed of water and the yellow color still persists. The temperatures at which the yellow form can exist in glass are shown by the behavior of cuprous oxide glass during its preparation. When 8% cuprous oxide is added to the glass it dissolves wholly at the temperature at which the glass is made, namely, 1000°C. If the glass is chilled rapidly, from this temperature, the resulting glass is nearly colorless, except for the unavoidable green color due to the part oxidation of some of the copper, and is nearly transparent. If this glass is reheated, depending on the temperature of reheat and the length of time of heating, comparatively large crystals or aggregations of crystals of red cuprous oxide result. Along with these are often found associated definite crystals of the yellow form, clouds of yellow particles; and if the heating be gentle, the particles of yellow cuprous oxide are so small as to be unseen under the microscope and the result is a clear yellow transparent glass. Hence from two forms of the same oxide of copper, we have a range of colors, depending on the proportion in which the two are mixed in the glass and the size of their particles. Much ancient Egyptian glass is of the type: silica, lime, soda, with varying amounts of potash, magnesia, and alumina. This resembles our window-glass compositions. Lead seems to be unused. The persistence of a scarlet color in

a glass like this has not been found possible due to the high temperature required for making. The ancient brown glass of the soda-lime type which seems to be so widely spread is dependent for its color upon the presence of finely divided metallic copper. One of the outstanding properties of cuprous oxide is that it does not form salts with acids except the halogen acids, hydrofluoric, hydrochloric, hydrobromic, and hydriodic. With the oxygen-containing acids (it reacts with them) metallic copper is produced along with the cupric salt of the acid. With sulphuric acid this change takes place at the ordinary temperatures; with a weaker acid, the action is very slow unless the temperature is raised. Taking these reactions as analogous to what may occur in a glass, and considering silica as a weak acid, it will be understood that if the temperature of a glass be raised high enough, the result will be the production of metallic copper dispersed through a greenish cupric oxide glass. A high percentage of cuprous oxide (8%) would possess enough green to make the red of copper, in reflected light, distinctly brown. With less copper present the color would approach nearer and nearer to the red. The transparent red copper glass and the brilliant *sang de boeuf* Chinese glazes are made under conditions which tend to reduce any cupric oxide which may be formed, so that the resulting glass is not rendered dingy by a green tint, due to dissolved cupric oxide marring the brilliant red due to the dispersed metallic copper. Only about 0.5% copper is used. Again the size of particles enters into the problem. This can readily be seen by the distribution of the particles in reference to the colors produced as viewed under the microscope of pieces of the same glaze from one *sang de boeuf* vase. It has been found that in a glass of the same composition, cupric oxide may give a very marked blue color if the glass is made at a comparatively low temperature (1000–1100°C); whereas with the same concentration of copper and the same glass made at a higher temperature, about 1300°C, there is a very marked shade of green in the blue. It is interesting to note that the blue low-temperature glass is green while still hot. A possible analogy is advanced between the action of water in solutions of cupric salts and the actions of the oxides of the alkali metals in glasses colored by cupric oxide. A study of the changes of color which can be produced in aqueous solutions and salts, and of the methods of modifying these colors, has been found to be a great aid in working out coloring schemes for glasses. Color effects are changed by merely adding water to a salt as for instance copper sulphate. The anhydrous salt with one molecule of water is colorless, while the same salt with 5 molecules of water is blue. With many glasses made at a high temperature cupric oxide gives an olive-green color, which is explained by the fact that some of the cupric oxide is reduced to the lower oxide of copper. With decided reducing conditions the same green glass will be a deep black through which the sun is invisible at a thickness of $^1/_{40}$ in. This is explained by assuming that the glass is a mixture of red copper glass and a green cupric oxide glass through which mixture little light could be transmitted. Red glass, owing its color to finely dispersed metallic copper, is rendered colorless by fusing and chilling rapidly. The above black glass might then be expected to become green if fused and quickly chilled, but it does not change from its intense black color. This allows the possibility of a cuproso-cupric compound being present in the glass analogous to the ferroso-ferric oxide, the well known black iron scale. Analogy with solutions might solve this or at least help. In experimenting with red copper glasses, and studying the way in which the red color can be prevented from developing by sudden chilling, and can be produced by subsequent heating, it was noticed that instead of obtaining a clear colorless glass in the bulbs made from the red glass and quickly chilled, the bulb has been sometimes of a dusky hue and sometimes of a definite neutral tint. This is attributed to a cuproso-cupric compound, which is stable in the glass, since no other coloring agent but copper was present in the glasses, and which is analogous to the

compound formed when the cuprous and cupric chloride solutions are mixed (resulting black), rather than to a physical mixture of the red and green glasses. Unlike cuprous oxide glasses, copper glasses, and many others such as gold, selenium, cadmium sulphide, and opal glasses, cupric oxide glasses cannot be rendered colorless by sudden chilling nor even modified in tinting. This seems to divide coloring agents into two classes. Colors are produced by the use of iron compounds as ferric oxide, ferroso-ferric oxide, and ferrous oxide; but there is probably no glass attributing its color to finely dispersed metallic iron. Ferrous oxide gives the characteristic green color of the nature of window glass and is considerably modified by the composition of the glass especially in the presence of a glass of zinc oxide or magnesium oxide. The former intensifies the color produced by any given amount of ferrous oxide and changes the usual green into almost a blue. Magnesium oxide acts in the same way except to a lesser degee. Among the alkalis, lithium oxide also tends to give a bluish tinge to glasses containing ferrous oxide. This is verified in some of the analyses of Chinese vases which were dependent on iron as the coloring agent and were, in addition, rich in lithium oxide and magnesium oxide. The range of colors possible in purchasing ferric oxide itself consists in obtaining reddish yellows through brick reds, bright reds to rich brown-reds, and almost to blacks. Some specimens show a bronze-like appearance. Its use in glasses and glazes produces greens. It is questioned whether the colors produced by the ferric oxide are due to compounds of this oxide with the other constituents of the glass. The method of dealing with this is by studying the effect of ferric oxide in lead glasses (flint glasses). There are two types of flint glasses, light flints and dense flints. In the former there is always present considerable alkali as potash or soda along with the lead oxide. In the latter the proportion of alkali is decreased and the amount of lead oxide increased. By adding even a small amount of ferric oxide to glasses varying in specific gravity from 3.2 to 4.8 it is found that the same amount of iron added to each produces a range in color from a colorless in the first case to a marked yellow color in the last. The low specific gravity glass contains considerable alkali and it is believed that this either promotes a formation of a compound of ferric oxide with the alkali or the formation of a double silicate, either sodium or potassium ferric silicate, such compounds appearing to be colorless. If the quantity of iron be increased, then a color can be produced in the light flint, 5% giving a strong yellow, 10% a deep brownish red, and 20% a still richer red color. It is believed that the light yellow color is due to a small amount of finely dispersed ferric oxide in the glass, the transparent deep yellows and brownish reds representing a greater concentration of ferric oxide similarly dispersed. The behavior of ferric oxide in a glass containing a large proportion of phosphoric acid, an acid which in glasses may be described as much stronger than silica, is next discussed. Ferric phosphate is a definite compound and is colorless; in this phosphoric acid glass considerable ferric iron may be present without evidence of color. Heating the glass in a highly reducing atmosphere proves that it exists in the ferric state, and the resulting glass is found to have developed a marked blue indigo color, thought to be due to ferrous phosphate, or else to a small amount of ferric phosphate with the already reduced ferrous phosphate. In such glasses as ordinary sodium calcium silicates it is rather difficult to produce light pure yellow colors with ferric oxide. Deep colored glazes as blacks in thick layers or fine golden browns in thin layers are possible by the use of ferric oxide and are known as feldspathic glazes and their compositions given as sodium or potassium calcium aluminum silicates. Amounts up to 12% of ferric oxide are required to produce these colors in the glazes. Increased amounts up to 20% cause the separation out of some of the ferric oxide on cooling, and according to the concentration of the ferric oxide, may be seen as a fine brown-red color on the surface of the glaze or as bronze-like spangles of ferric oxide, rosettes,

tree-like crystals, or even more massive crystals, which to the eye appear black. The Chinese made much use of this behavior of ferric oxide in the varied and beautiful decorations of their porcelains. Ferroso-ferric oxide, magnetic oxide of iron, gives in certain glasses neutral tints of various depths, but with high concentration of this oxide a black glass can be obtained. If the concentration of the ferroso-ferric oxide be high enough, some of this oxide will separate out on cooling so as to be dispersed through the glass in very minute aggregations which are presumably crystalline, since the resulting glass is appreciably magnetic. This applies only to glasses having all of their iron in the ferroso-ferric form. If the ferrous iron glass or glaze contains some ferric iron, the green color due to the ferrous iron will be modified and various olive green tints can be obtained. Many colored glazes containing enough iron in the ferrous state, and sufficient in the ferric state also, cause an olive green to be produced. In a similar way small quantities of ferrous iron will modify the yellow or brown colors due to the ferric iron and give dusky hues. In attempting to account for the coloring matter in lapis lazuli, it is brought out that in nearly all specimens observed, crystals of iron sulphide were present, which closely resembled under the microscope except for the color, the glazes colored by ferric oxide in which crystals of ferric oxide can also be seen. It is thought that the intense and beautiful blue color of lapis lazuli is due to minute particles of ferric sulphide, too small to be seen by the microscope, dispersed through the mineral. Different concentrations of the dispersed ferric sulphide would account for the various lighter blues, full blues and dark, almost black-blues, which can be seen in specimens of lapis lazuli. It is also noted that in the manufacture of artificial ultramarine by heating together clay, sodium carbonate, sulphur, and charcoal or some other substance rich in carbon, small amounts of iron must be present in the materials. The color developed in a glass by exposure to the sunlight is partly determined by the composition of the glass. It is quite common in window glass, subjecting to long exposure in the sunlight, to develop colors ranging from pink, through various depths of rose-violet, almost to a marked blue-violet. Some even assumes a brownish yellow tint. The ultra-violet, X-ray, and radiations from radium will all have effect on changing the color of the glass after a period of exposure, the color change not being necessarily the same as when subjected to the sunlight. It is suggested that the oxidation of some of the ingredients added as coloring agents by these rays causes the change in color. It has been found possible to decolorize all colored glasses, whose coloring is found due to the actions of radiations, at some temperature appropriate for that operation. Just as glasses can be decolorized so can many of the natural minerals in which the coloring is thought to be due to radiations. Highly colored fluorspar, purple amethyst, smoky quartz, rose quartz, yellow quartz, and various colored zircons are all examples. All of these were decolorized by heating to the appropriate temperature and when decolorized show a marked absorption in some part or other of the ultra-violet spectrum. Some of the specimens as amethystine quartz, etc., can have their colors again restored by exposure to γ rays of radium. In the production of these colors by radiations there appears to be some analogy between them and the color changes which are observed in silver salts on exposure to light. It is suggested that the colors produced in this experiment are ascribable to the separation from the material of one or more of its constituents by radiation, which separation is only possible provided there is present in the material a suitable impurity. On the other hand, however, there are facts which strongly point to the view that it is the impurity itself, in many cases, that becomes separated out in a fine state of division by the radiations and which imparts the color to the glass or mineral. P.F.C.

Copper red glazes maturing at low temperatures. ANON. *Keramos*, **6** [9], 334–36 (1927).—This article deals with an investigation concerning the subject of the develop-

ment of Chinese-red glazes that mature at low temperatures. Copper oxide in amounts varying from 0.5 to 1.5% was added to the following base glaze;

$$\left.\begin{matrix}.5\ K_2O\\ .5\ CaO\end{matrix}\right\}.1\ Al_2O_3\left\{\begin{matrix}2.5\ SiO_2\\ 1.0\ B_2O_3\end{matrix}\right.$$

The amount of copper oxide may be 0.5% in case the glaze is fritted. A firing schedule is given. The kiln atmosphere is maintained reducing up to the maturing temperature which was found, by means of trials, to be Seger cone 06a. The color obtained was a carmine red. F.P.H.

Variation of the metallic oxide colors. ANON. *Keramos*, **6** [9], 343–45 (1927).—A study is made of the effect of the composition of the base glaze on the resulting colors obtained when various coloring oxides are added to these glazes. The glazes studied were fritted in a crucible, applied to whiteware plates, and fired in a muffle to a temperature varying from 1000 to 1100°C. The coloring oxides were added to the following base glazes:

(1) $1\ SiO_2\ .1\ Al_2O_3PbO$

(2) $1\ SiO_2\ .1\ Al_2O_3K_2O$

(3) $1\ SiO_2\ .1\ Al_2O_3Na_2O$

(4) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.5\ PbO\\ .5\ CaO\end{matrix}\right.$

(5) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.5\ MgO\\ .5\ PbO\end{matrix}\right.$

(6) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.5\ PbO\\ .5\ BaO\end{matrix}\right.$

(7) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.5\ PbO\\ .5\ SrO\end{matrix}\right.$

(8) $1\ SiO_2\ .1\ Al_2O_3ZnO$

(9) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.25\ K_2O\\ .25\ Na_2O\\ .50\ CaO\end{matrix}\right.$

(10) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.25\ K_2O\\ .25\ Na_2O\\ .50\ CaO\end{matrix}\right.$

(11) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.25\ K_2O\\ .25\ Na_2O\\ .50\ MgO\end{matrix}\right.$

(12) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.25\ K_2O\\ .25\ Na_2O\\ .50\ SrO\end{matrix}\right.$

(13) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.25\ K_2O\\ .25\ Na_2O\\ .50\ ZnO\end{matrix}\right.$

(14) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.50\ PbO\\ .50\ ZnO\end{matrix}\right.$

(15) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.5\ ZnO\\ .5\ CaO\end{matrix}\right.$

(16) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.50\ ZnO\\ .50\ BaO\end{matrix}\right.$

(17) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.50\ SrO\\ .50\ ZnO\end{matrix}\right.$

(18) $1\ SiO_2\ .05\ Al_2O_3\left\{\begin{matrix}.50\ MgO\\ .50\ ZnO\end{matrix}\right.$

Glaze No.	NiO 3%	Cr_2O_3 3%	Sb_2O_3 3%	CoO 1%	Fe_2O_3 6%
1	pale yellow-gray	vermilion	light opaque honey-yellow	cobalt blue	delicate honey-yellow
2	clear deep violet	green	white partly opaque	bright violet-blue	gray-green
3	deep violet	green-yellow lemon-yellow	white opaque	ultramarine	delicate sea-green
4	dirty gray-brown	yellow to dark green	light lemon-yellow	opaque cobalt blue	light yellow-brown
5	gray-brown	opaque brownish green	opaque honey-yellow	lavender-blue	opaque brownish yellow
6	deep metallic brown (mat)	lemon-yellow	white partly opaque	bright cobalt blue	brownish yellow
7	dark brown	dark brownish green	nearly colorless	bright cobalt blue	greenish brown

Glaze No.	NiO 3%	Cr_2O_3 3%	Sb_2O_3 3%	CoO 1%	Fe_2O_3 6%
8	yellow-brown				
9	deep black brown (mat)	green-yellow (mat)	white opaque	cobalt blue	yellow and brown crystals (mat)
10	violet-brown	light yellow-green	gray-white opaque	cobalt blue	honey-yellow
11	deep black brown entirely (mat)	opaque yellow-green	white opaque	opaque cobalt blue	opaque brown
12	light green	opaque yellow-green	white opaque	violet streaks cobalt blue	green-yellow green-brown
13	yellow glaze with turquoise crystals	opaque green-gray	partly opaque gray-white	cobalt blue large crystals in streaks	yelllow-brown
14	brown-yellow glaze with blue-green crystals	dark brown	light yellow	cobalt blue large crystals in streaks	sparkling gold-brown
15	gray-blue (mat)	green-gray shading off to brown	white opaque	blue (mat)	gold-brown
16	dark brown lilac	grown-green	colorless	ultramarine (mat)	opaque green-brown
17	green to red-gray*	gray*	ash-gray*	light blue*	brown*
18	light turquoise*	green to violet-brown	white*	light blue*	brown*

* Not matured at 1250°C

Salt-glaze formation. W. FISCHER. Dissertation, Breslau, 1926; *Keramos*, **6** [10], 398 (1927). F.P.H.

Formation and decomposition of zinc ferrite. CARL E. SWARTZ AND FRANCIS C. KRAUSKOPF. *Min. and Met.*, **9** [253], 28 (1928).—At 150°C pyrite begins to lose sulphur. As the temperature increases, while the ore is passing to the hotter part of the furnace, the sulphur burns to sulphur dioxide, leaving the metals as zinc oxide and ferric oxide. These two substances then interact to form zinc ferrite, a compound, yellow-brown in color, having the general characteristics of a spinel. Like magnetite, another spinel, zinc ferrite is insoluble in alkalis and dilute acids. As a result, when leached with 10% sulphuric acid solution, zinc in this compound remains behind. Zinc ferrite, artificial Franklinite, $Zn(FeO_2)_2$, was prepared by heating an intimately mixed powder of zinc oxide and ferric oxide at or above 650°C. The reaction is rapid, being complete at the end of 1 or 2 hours. Continued heating, or higher temperatures of heating, do not affect the formation of the compound. It may be decomposed by mixing with calcium oxide or magnesium oxide and heating to 850°C. The reaction, however, is not complete at this temperature. The fact that zinc ferrite can be decomposed indicates a possibility of increasing the recovery of zinc by such a method. F.P.H.

Chinese stoneware: 3rd to 10th Century A.D. ANON. *Illust. London News*, **171,** 1041 (1927).—Remarkably interesting photographs of heavy stoneware from the Wei to the T'ang dynasties. They are all of horses, with and without riders. The pottery is covered with a slip, and with red, black, turquoise, pink, and carmine pigments. H.H.S.

Roman temple to Alpine gods. O. TSCHUMI. *Illust. London News*, **171,** 1188 (1927).—In April, 1927, a farmer ploughing near Almendingen, on the Lake of Thun, struck

his plough-share against an old Roman altar. Investigation brought to light paving stones, a clay bath-tub used in the worship of Attis Kybele, votive offerings to Asiatic and Roman gods, marble statuettes (including one of a forerunner of the St. Bernard dog). T. supposes that here stood a central temple housing a collection of gods. H.H.S.

Roman temple found at Harlow. M. CHRISTY AND MORTIMER WHEELER. *Illust. London News*, **171,** 1189 (1927).—Excavations of "The Mound" at Harlow in Essex have revealed, not, as expected, the remains of a Roman fort, but the foundations of a temple of the 3rd Century with bricks, tile fragments of tessellated pavement, coins, brooches, and weapons. H.H.S.

Underglaze decorations of white ware with salt solutions. TORU AKIZUKI. *Report of Korea Central Lab.*, **8** [4], 17–23 (1925).—Whiteware biscuits were painted with salt solutions of Co, Mn, Ni, U, Cr, Fe, Au, and Pt and fired again to cone 7. They were then coated with several glazes and glost-fired to cones 10, 12, 14, and 18. Results: (*a*) coloration of Co (sulphate), Cr, and Pt is most stable and strong; the colors do not run; (*b*) that of Mn and Fe is very weak and is useless; (*c*) that of Ni and Au is moderate and somewhat unstable; the colors run most badly; (*d*) that of U is moderate but is very unstable; (*e*) the color of cobalt nitrate is weak and spreads badly; (*f*) of various mixed solutions, that of cobalt sulphate and chromium nitrate gives the best result. S.K.

Metal mold for sculptured tile. KIYOSHI MITSUHASHI *Jour. Jap. Ceram. Assn.*, **33** [387], 82–92 (1925).—Experiments on the manufacture of metal mold for sculptured wall tile are reported. Satisfactory results were obtained by casting a fusible alloy, consisting of 3 g. cadmium, 15 g. bismuth, 4 g. tin, and 8 g. lead, in a mold made of plaster of Paris which had previously been coated with a solution composed of 100 g. $CaCl_2$, 100 g. water, and 12–25 g. glycerine. S.K.

Zinc crystal glaze. SEIJI KONDO. *Jour. Jap. Ceram. Assn.*, **33** [389], 165–81 (1925). —The glazes were applied on biscuited porcelain tile which were then placed flat in saggers and fired in a coal-fired kiln. Expt. 1. $\left.\begin{matrix}0.3\text{–}0.5\ K_2O\\0.7\text{–}0.5\ ZnO\end{matrix}\right\}\ 0.5\text{–}2.0\ SiO_2$ (cones 8, 10, and 12). The best result was obtained with $\left.\begin{matrix}0.3\ K_2O\\0.7\ ZnO\end{matrix}\right\}\ 1.1\ SiO_2$; 0.8 SiO_2, and $\left.\begin{matrix}0.34\ K_2O\\0.66\ ZnO\end{matrix}\right\}\ 1.1\ SiO_2$ fired to cone 10. Expt. 2. $\left.\begin{matrix}0.3\text{–}0.1\ K_2O\\0.7\text{–}0.9\ ZnO\end{matrix}\right\}\ 0.5\text{–}2.0\ SiO_2$ (cones 8, 12, 14, and 16). (*a*) $\left.\begin{matrix}0.2\ K_2O\\0.8\ ZnO\end{matrix}\right\}\ 0.7\text{–}1.2\ SiO_2$ at cone 14 and $\left.\begin{matrix}0.1\ K_2O\\0.9\ ZnO\end{matrix}\right\}\ 0.6\text{–}1.0\ SiO_2$ at cone 16 were excellent; (*b*) $\left.\begin{matrix}0.1\ K_2O\\0.9\ ZnO\end{matrix}\right\}\ 0.7\ SiO_2$ fired to cone 16 was the best glaze obtained in the experiments. Expt. 3. $\left.\begin{matrix}0.3\text{–}0.5\ Na_2O\\0.7\text{–}0.5\ ZnO\end{matrix}\right\}\ 0.5\text{–}2.0\ SiO_2$ (cones 8, 10, and 12). $\left.\begin{matrix}0.3\ Na_2O\\0.7\ ZnO\end{matrix}\right\}\ 0.8\ SiO_2$ at cone 10 was most promising. Expt. 4. $\left.\begin{matrix}0.1\text{–}0.3\ K_2O\\0.9\text{–}0.7\ ZnO\end{matrix}\right\}$ $0.6\text{–}2.0\ SiO_2$ $0.1\text{–}0.3\ B_2O_3$ (cones 10, 12, and 14). $\left.\begin{matrix}0.25\ K_2O\\0.75\ ZnO\end{matrix}\right\}\ \begin{matrix}1.0\ SiO_2\\0.25\ B_2O_3\end{matrix}$ and $\left.\begin{matrix}0.3\ K_2O\\0.7\ ZnO\end{matrix}\right\}\ \begin{matrix}1.4\ SiO_2\\0.3\ B_2O_3\end{matrix}$ at cone 10; $\left.\begin{matrix}0.2\ K_2O\\0.8\ ZnO\end{matrix}\right\}\ \begin{matrix}1.4\text{–}1.8\ SiO_2\\0.2\ B_2O_3\end{matrix}$ and $\left.\begin{matrix}0.25\ K_2O\\0.75\ ZnO\end{matrix}\right\}\ \begin{matrix}0.6\text{–}0.8\ SiO_2\\0.25\ B_2O_3\end{matrix}$ at cone 12; and $\left.\begin{matrix}0.2\ K_2O\\0.8\ ZnO\end{matrix}\right\}\ 0.6, 1.0\text{–}1.4,\ \begin{matrix}1.8\ SiO_2\\0.2\ B_2O_3\end{matrix}$ and $\left.\begin{matrix}0.25\ K_2O\\0.75\ ZnO\end{matrix}\right\}\ \begin{matrix}0.6, 1.2\ SiO_2\\0.25 B_2O_3\end{matrix}$ at cone 14 were good. Similar experiments with porcelain cups gave only one fine glaze $\left.\begin{matrix}0.2\ K_2O\\0.8\ ZnO\end{matrix}\right\}\ \begin{matrix}2.0\ SiO_2\\0.2\ B_2O_3\end{matrix}$ at cone 12. S.K.

Mineralogical characteristics and chemical composition of crystals produced in

zinc crystal glazes. SEIJI KONDO. *Jour. Jap. Ceram. Assn.*, **33** [389],182–88 (1925).—Mineralogical character and chemical composition of crystals produced in zinc crystal glazes have been studied. *Chapt. I. Mineralogical character of the crystals.* A frit $\left.\begin{matrix}0.3\ Na_2O\\0.7\ ZnO\end{matrix}\right\}0.5\ SiO_2$ was applied very thick on convex surface of biscuited porcelain tile. Most of samples, matured at cone 12, were entirely covered with thick, long crystals. Their thin sections were examined under a microscope. The crystals are fine white parallel fibers with silky luster cemented by glass. They end at symmetrical spear-head. The crystal is a combination of R and ∞P_2 and shows hexagonal outline, 0.0226–0.565 mm. wide, if seen at c-axis resembling the pegmatite quartz in its form. There are numerous negative crystals. The crystals group in hexagonal skeletal arrangement. The fibers are twisted spirally. Optical properties are: n about 1.60, double refraction nearly as strong as augite, and interference color high as augite. Interference figure shows that the crystal is uniaxial. It is optically positive. Cleavage is likely *R*. *Chapt. II. Chemical composition.* Glaze 1: $\left.\begin{matrix}0.3\ Na_2O\\0.7\ ZnO\end{matrix}\right\}0.5\ SiO_2$. The formula of the frit, calcined from its analysis, is $\left.\begin{matrix}0.253\ Na_2O\\0.022\ K_2O\\0.705\ ZnO\\0.009\ CaO\\0.011\ MgO\end{matrix}\right\}0.014\ Al_2O_3(Fe_2O_3).\ 0.505\ SiO_2$. The glaze, prepared as described above and looking like a mass of long thick crystals, was coarsely ground and white grains free from glass were collected under microscope for analysis. Results are: 1st firing $(a)\left.\begin{matrix}0.262\ Na_2O\\0.035\ K_2O\\0.662\ ZnO\\0.041\ CaO\end{matrix}\right|\left.\begin{matrix}0.060\ Al_2O_3\\0.014\ Fe_2O_3\end{matrix}\right\}$

$0.994\ SiO_2$; $(b)\left.\begin{matrix}0.245\ Na_2O\\0.032\ K_2O\\0.699\ ZnO\\0.024\ CaO\end{matrix}\right|\left.\begin{matrix}0.066\ Al_2O_3\\0.015\ Fe_2O_3\end{matrix}\right\}1.036\ SiO_2$; 2nd firing $(a)\left.\begin{matrix}0.255\ Na_2O\\0.043\ K_2O\\0.646\ ZnO\\0.017\ MgO\end{matrix}\right|\left.\begin{matrix}0.104\ Al_2O_3\\0.010\ Fe_2O_3\end{matrix}\right\}1.264\ SiO_2$; $(b)\left.\begin{matrix}0.241\ Na_2O\\0.057\ K_2O\\0.646\ ZnO\\0.039\ CaO\\0.017\ MgO\end{matrix}\right|\left.\begin{matrix}0.112\ Al_2O_3\\0.008\ Fe_2O_3\end{matrix}\right\}1.267\ SiO_2$. Glaze 2: $\left.\begin{matrix}0.3\ K_2O\\0.7\ ZnO\end{matrix}\right\}0.5\ SiO_2$. Chemical formulas of the frit and crystals obtained are: Frit $\left.\begin{matrix}0.280\ K_2O\\0.031\ Na_2O\\0.657\ ZnO\\0.019\ CaO\\0.013\ MgO\end{matrix}\right|\left.\begin{matrix}0.010\ Al_2O_3\\0.003\ Fe_2O_3\end{matrix}\right\}0.501\ SiO_2$ and crystals $\left.\begin{matrix}0.182\ K_2O\\0.086\ Na_2O\\0.671\ ZnO\\0.052\ CaO\\0.009\ MgO\end{matrix}\right|\left.\begin{matrix}0.076\ Al_2O_3\\0.013\ Fe_2O_3\end{matrix}\right\}$

$1.141\ SiO_2$. Glaze 3. $\left.\begin{matrix}0.3\ K_2O\\0.7\ ZnO\end{matrix}\right\}1.0\ SiO_2$. The frit has not been analyzed. Chemical formula of the crystals, calcined from their analysis, is $\left.\begin{matrix}0.198\ K_2O\\0.064\ Na_2O\\0.723\ ZnO\\0.008\ CaO\\0.007\ MgO\end{matrix}\right|\left.\begin{matrix}0.030\ Al_2O_3\\0.003\ Fe_2O_3\end{matrix}\right\}$

1.171 SiO_2. Glaze 4: Effect of glass cementing crystal fibers on their analysis. The same sample for the analyses of the glaze $\left.\begin{matrix}0.3\ Na_2O\\0.7\ ZnO\end{matrix}\right\}$ 0.5 SiO_2, 2nd firing (*a*) and (*b*), was ground fine and pure particles were collected under microscope between crossed nicols requiring over a month to get about 0.1 g. The formula obtained this time was $\left.\begin{matrix}0.25\ Na_2O\\0.04\ K_2O\\0.63\ ZnO\\0.05\ CaO\\0.03\ MgO\end{matrix}\right\}$ $\left.\begin{matrix}0.11\ Al_2O_3\\0.01\ Fe_2O_3\end{matrix}\right\}$ 1.19 SiO_2. Thus the effect of the glass is unexpectedly slight. Conclusion: The crystals are likely a solid solution of $ZnSiO_3$ and a minor proportion of R_2SiO_3. This agrees well with the fact that the glazes $\left.\begin{matrix}0.3\text{–}0.1\ K_2O\\0.7\text{–}0.9\ ZnO\end{matrix}\right\}$ 0.5–1.0 SiO_2 are entirely filled with the crystals if fired properly. S.K.

Colored zinc crystal glazes. SEIJI KONDO. *Jour. Jap. Ceram. Assn.*, **33** [389], 188–202 (1925).—**I.** Various coloring oxides were introduced into $\left.\begin{matrix}0.3\ K_2O\\0.7\ ZnO\end{matrix}\right\}$ 0.8–2.0 SiO_2, replacing K_2O except Fe_2O_3, UO_3, Cr_2O_3, and SnO_2 which were merely added. The glazes were applied on hard biscuited porcelain cups and fired to cones 8, 10, 12, and 14. Nice glazes were obtained with the following proportions: 0.1 CuO–0.8 SiO_2 (cone 12); 0.050–0.075 CuO–0.8 SiO_2 (cone 14); 0.050 CuO–0.013 CoO–0.8 SiO_2 (cone 14); 0.025 CuO–0.038 CoO–0.8 SiO_2 (cone 14); 0.038–0.025 NiO–0.8 SiO_2 (cone 12); 0.075 Fe_2O_3–0.8 SiO_2 (cone 12); 0.038–0.000 NiO–0.025–0.100 Fe_2O_3–0.8 SiO_2 (cone 12); 0.025–0.050 Fe_2O_3–0.8 SiO_2 (cone 14); 0.013 NiO–0.000–0.025 Fe_2O_3–0.8 SiO_2 (cone 14); 0.038 NiO–0.8 SiO_2 (cone 14); 0.1 MnO–0.8 SiO_2 (cone 10); 0.05–0.10 MnO–0.8 SiO_2 (cone 12); 0.075 MnO–0.01 UO_3–0.8 SiO_2 (cone 12); 0.033–0.017 MnO–0.067–0.083 Fe_2O_3–1.6–1.8 SiO_2 (cone 10); 0.067–0.050 MnO–0.033–0.050 Fe_2O_3–1.2–1.4 SiO_2 (cone 12); 0.1 CuO–2.0 SiO_2 (cone 10); 0.033–0.025 NiO–0.033–0.050 CuO–1.2–1.4 SiO_2 (cones 10 and 12); 0.05 NiO–0.8 SiO_2 (cone 12); 0.042–0.050 CoO–0.0017–0.0000 Cr_2O_3–1.8–2.0 SiO_2 (cones 10 and 12); 0.033 CoO–0.0033 Cr_2O_3–1.6 SiO_2 (cone 12); 0.00033 Cr_2O_3–0.033 UO_3–1.8 SiO_2–0.083 SnO_2 (cones 10 and 12); and 0.00067 Cr_2O_3–0.027 UO_3–1.6 SiO_2–0.067 SnO_2 (cone 12). **II.** $\left.\begin{matrix}0.3\ Na_2O\\0.7\ ZnO\end{matrix}\right\}$ 0.8–2.0 SiO_2 were experimented similarly with Fe_2O_3 and CuO and fired to cones 8, 10, and 12. Fine glazes obtained are: 0.15–0.10 Fe_2O_3–1.7–1.4 SiO_2 (cone 10), 0.050 CuO–0.10 Fe_2O_3–1.4 SiO_2 (cone 10), and 0.10 CuO–0.8 SiO_2 (cone 10). **III.** Results of the experiments in which various colored zinc crystal glazes were applied on glost-fired porcelain cups with zinc glazes are reported. S.K.

Manganese crystal glaze. SEIJI KONDO. *Jour. Jap. Ceram. Assn.*, **33** [393], 387–98 (1925).—Experiments on various Mn crystal glazes are reported. The fritted glazes are applied on hard-biscuited tile of a porcelain and fired with neutral flame in a coal-fired kiln. Expts. 1 and 2: $\left.\begin{matrix}0.3\text{–}0.6\ K_2O\\0.7\text{–}0.4\ MnO\end{matrix}\right\}$ 0.5–2.0 SiO_2 and $\left.\begin{matrix}0.3\text{–}0.6\ Na_2O\\0.7\text{–}0.4\ MnO\end{matrix}\right\}$ 0.5–2.0 SiO_2 (cones 8, 10, and 12). The growth of the crystals is encouraged by the increase in Mn or by the decrease in SiO_2. The development of small lobster shell-like crystals is better in soda glazes than in potash glazes. Expt. 3: $\left.\begin{matrix}0.3\text{–}0.0\ K_2O\\0.3\text{–}0.3\ Na_2O\\0.7\ MnO\end{matrix}\right\}$ 2.0 SiO_2 (cones 8, 10, and 12). There is no remarkable difference between the glazes except that those rich in potash are most glossy. Expt. 4: Pyroxene glazes $R\ SiO_3 + {}^1/_4\ K_2SiO_3$ where R = Mn, Ca, Fe (cones 8, 10, 12, and 14). The more CaO in the glazes the

better the development of the crystals. All iron glazes with 0.4 MnO or more have shown iridescent black scaly texture at cone 14. In this and following two experiments cone 12 is most suitable. Expt. 5: R = Mn, Mg, Zn. Crystals grow better as MgO or ZnO increase. Expt. 6: Pyroxene glaze $R\,SiO_3 + {}^1/_4K_2B_2O_4$ where R = Mn, Ca, Fe (cones 8, 10, 12, and 14). Ca is most favorable for the development of crystals; at cone 14 most of the Ca crystals disappear and minute scaly crystals form in glazes very rich in Fe. Expt. 7: Pyroxene glaze $R\,SiO_3 + {}^1/_4K_2B_2O_4$, where R = Mn, Mg, Zn. Crystals are found in all members containing Mg at every firing temperature with a few exceptions. The best results are obtained at cones 12 and 14. Expt. 8: Olivine glazes $R_2SiO_4 + {}^1/_2K_2B_2O_4$ where R = Mn, Ca, Fe (cones 8, 10, 12, and 14). Generally speaking, glazes, which contain Ca and are poor in Fe, crystallize at cones 8–12, although nice graphitic crystals are produced in those rich in Fe at cone 14. Expt. 9: Olivine glazes $R_2SiO_4 + {}^1/_2K_2B_2O_4$, where R = Mn, Mg, Zn. The crystallization is favored most by Mg. S.K.

Crystal glazes based on the composition of minerals. I. SEIJI KONDO. *Jour. Jap. Ceram. Assn.*, **33** [393], 399–418 (1925).—Crystal glazes based on the compositions of various minerals have been studied. In the main the frits were applied on concave hard-biscuited tile of a porcelain with the aid of tragacanth. They were then placed in saggers and fired in a coal-fired kiln. *Chapt. I. Orthorhombic pyroxenes and amphiboles.* Glaze formulas: (*A*) $MgSiO_3$ (enstatite) $+ {}^1/_4K_2B_2O_4$; (*B*) $\left.\begin{matrix}0.5\ MgO\\0.5\ FeO\end{matrix}\right\}$ SiO_2 (hypersthene) $+ {}^1/_4K_2B_2O_4$; and (*C*) $\left.\begin{matrix}0.9\ MgO\\0.1\ FeO\end{matrix}\right\}$ $0.3\ Al_2O_3 \cdot 1.0\ SiO_2$ (gedrite) $+ {}^1/_4K_2B_2O_4$ as Nos. 1, 16, and 21 respectively of a triaxial diagram of 21 members. Fired to cones 10, 12, 14, and 16. Results are (*a*) no glaze without crystals; (*b*) striking changes observed in crystal shape with firing temperatures; (*c*) 11 excellent and 5 good glazes obtained at cone 14. *Chapt. II. Diopside.* (1) Ideal diopside and hedenbergite. Formulas: (*A*) $\left.\begin{matrix}0.5\ CaO\\0.5\ MgO\end{matrix}\right\}$ SiO_2 (diopside) $+ {}^1/_4K_2B_2O_4$; (*B*) $\left.\begin{matrix}0.5\ CaO\\0.5\ FeO\end{matrix}\right\}$ SiO_2 (hedenbergite) $+ {}^1/_4K_2B_2O_4$; and (*C*) $\left.\begin{matrix}0.5\ CaO\\0.5\ MgO\end{matrix}\right\}\left.\begin{matrix}0.75\ SiO_2\\0.25\ TiO_2\end{matrix}\right\} + {}^1/_4K_2B_2O_4$ compounded to form a 21-member triaxial diagram. Fired to cones 10, 12, and 14. Results: (*a*) no crystal found in glazes rich in (*B*); (*b*) crystals on the line *A*–*B* were coarse and granular, which passed gradually into fine prisms as the content of (*C*) increased. (2) Natural diopside. Fired to cones 8 and 10. Experiment 1: Formulas: (*A*) $\left.\begin{matrix}0.49\ CaO\\0.49\ MgO\\0.02\ FeO\end{matrix}\right\}$ $1\ SiO_2 + {}^1/_4K_2B_2O_4$; (*B*) $\left.\begin{matrix}0.41\ CaO\\0.51\ MgO\\0.08\ FeO\end{matrix}\right\}$ $1\ SiO_2 + {}^1/_4K_2B_2O_4$; and (*C*) $\left.\begin{matrix}0.41\ CaO\\0.08\ MgO\\0.51\ FeO\end{matrix}\right\}$ $1\ SiO_2 + {}^1/_4K_2B_2O_4$ as Nos. 1, 16, and 21 respectively of the triaxial diagram. Most glazes were overmatured at cone 8 and granular crystals were formed on all of them except (*C*) which was a plain glaze. The crystals of (*A*) were best defined. Expt. 2: Formulas same as Expt. 1 but 0.03 Al_2O_3 added. Results: (*a*) all glazes crystallized at cone 8; (*b*) 3 fairly good glazes at cone 10. Expt. 3: Formulas same as Expt. 1 but 0.01 Cr_2O_3 added. Results: (*a*) all glazes crystallized; (*b*) biggest crystals found on glazes containing 0.6 equivalent of (*C*); (*c*) their habit was needle-shaped around (*B*) and granular around (*C*). Expt. 4: Formulas same as Expt. 1, but with $\left.\begin{matrix}0.096\ SiO_2\\0.04\ TiO_2\end{matrix}\right\}$ in place of $1\ SiO_2$. Needle-shaped or granular crystals were produced on all glazes. Expt. 5: Formulas same Expt. 1, but with 0.02 MnO. Results: (*a*) granular crystals developed in all

numbers; (*b*) a fairly good glaze at cone 10. *Chapt. III. Augite.* Fired to cones 8, 10, 12, and 14. Expt. 1. Formulas: (*A*) $\left.\begin{matrix}0.65\ CaO\\0.30\ MgO\\0.05\ FeO\end{matrix}\right\}$ $0.03\ Al_2O_3 \cdot 1\ SiO_2 + {}^1/_4K_2B_2O_4$; (*B*) $\left.\begin{matrix}0.30\ CaO\\0.65\ MgO\\0.05\ FeO\end{matrix}\right\}$ $0.03\ Al_2O_3 \cdot 1\ SiO_2 + {}^1/_4K_2B_2O_4$; and (*C*) $\left.\begin{matrix}0.30\ CaO\\0.30\ MgO\\0.40\ FeO\end{matrix}\right\}$ $0.03\ Al_2O_3 \cdot 1\ SiO_2 + {}^1/_4K_2B_2O_4$. Results: (*a*) all glazes crystallized at cone 8; (*b*) 4 fairly good glazes obtained at cone 14. Expt. 2: Formulas same as Expt. 1 but 0.15 Al_2O_3 added. In general, crystals were finer than above. Expt. 3. Formulas same as with Expt. 1, but 0.008 Cr_2O_3 added. Cr_2O_3 made the crystals slender. Expt. 4: Formulas same as Expt. 1 but with $\left.\begin{matrix}0.93\ SiO_2\\0.07\ TiO_2\end{matrix}\right\}$ instead of 1 SiO_2. The crystals were slender. Expt. 5. Formulas same as with Expt. 1 with 0.007 MnO added. Crystals were increased in their number and size. *Chapt. IV. Diopside-acmite-jadeite.* Formulas: (*A*) $CaO(0.06\ MgO,\ 0.4\ FeO)(SiO)_2$ (diopside); (*B*) $NaFe(SiO_3)_2$ (acmite), and (*C*) $(NaAlSiO_3)_2$ (jadeite) compounded to form a triaxial diagram. Scaly crystals were produced on glazes containing (*B*) at cone 12. *Chapt. V.* Schefferite-jeffersonite-babingtonite. Obscure minute crystals were formed on a schefferite glaze at cone 6a. **II.** *Ibid.*, **34** [405], 411–31 (1926).—*Chapt. VI. Olivine group.* In most of the folfowing experiments, each 21 members composed of frits (*A*), (*B*), and (*C*) to form a triaxial diagram have been applied on hard biscuited tiles of a porcelain and fired to cones 6a, 12, 14, and 16. Expt. 1. Formulas: (*A*) $Mg_2SiO_4 + {}^1/_2K_2B_2O_4$; (*B*) $Fe_2SiO_4 + {}^1/_2K_2B_2O_4$; and (*C*) $Mn_2SiO_4 + {}^1/_2K_2B_2O_4$. Results: (*a*) crystals produced in all glazes except (*A*); their shapes were markedly influenced by the firing temperature; (*b*) obtained a fairly good glaze at cone 6a, 4 fairly good and 6 good ones at cones 12 and 13; excellent glazes at cone 14. Expt. 2. Formulas: (*A*) $Zn_2SiO_4 + {}^1/_2K_2B_2O_4$; (*B*) $Fe_2SiO_4 + {}^1/_2K_2B_2O_4$; and (*C*) $Mn_2SiO_4 + {}^1/_2K_2B_2O_4$. Results: (*a*) less crystallizable than in Expt. 1; (*b*) fairly good glaze at cone 6a; 8 fairly good, and 4 good ones at cone 12; and 4 fairly good and 1 good glaze at cone 14. Expt. 3. Formulas: (*A*) $CaMgSiO_4 + {}^1/_2K_2B_2O_4$; (*B*) $CaFeSiO_4 + {}^1/_2K_2B_2O_4$; and (*C*) $CaMnSiO_4 + {}^1/_2K_2B_2O_4$. Results: (*a*) All matured at cone 6a; (*b*) less crystallizable than glazes of Expt. 2; (*c*) no satisfactory glaze found. Expt. 4. Formulas: (*A*) $Ca_2SiO_4 + {}^1/_2K_2B_2O_4$, (*B*) $Mg_2SiO_4 + {}^1/_2K_2B_2O_4$; and (*C*) $CaMg(0.7\ Si, 0.3\ Ti)O_4 + {}^1/_2K_2B_2O_4$. Results: (*a*) 2 fairly good glazes at cone 12. *Chapt. VII. Gehlenite-akermanite.* 35 glazes prepared from frit (*A*) $3\ CaO \cdot Al_2O_3 \cdot 2\ SiO_2$ (gehlenite) $+ {}^3/_4K_2B_2O_4$; (*B*) $3\ MgO \cdot Al_2O_3 \cdot 2\ SiO_2 + {}^3/_4K_2B_2O_4$; (*C*) $3\ CaO \cdot 2\ SiO_2$ (akermanite) $+ {}^3/_4K_2B_2O_4$; and (*D*) $3\ MgO \cdot 2\ SiO_2 + {}^3/_4K_2B_2O_4$ were fired to cones 6a, 8, and 10. The results are shown with tables. No satisfactory glaze obtained. *Chapt. VIII.* Glazes: $\left.\begin{matrix}1.0\text{–}0.0\ CaO\\0.0\text{–}1.0\ MgO\end{matrix}\right\}$ $0.2\text{–}2.0\ SiO_2 + {}^1/_4Na_2B_2O_4$. 209 glazes varying by 0.1 equivalent in CaO, MgO, and SiO_2 have been fired to cones 4a, 8, and 12. Very interesting results are shown with tables, followed by conclusions and discussions. *Chapt. IX.* $\left.\begin{matrix}1.0\text{–}0.0\ CaO\\0.0\text{–}1.0\ MgO\end{matrix}\right\}$ $0.5\text{–}1.0\ SiO_2 + {}^1/_4Na_2B_2O_4$. This is a repetition of the preceding experiment, omitting less important portions and varying CaO, MgO, and SiO_2 by 0.05 equivalent. The results are shown with tables and are discussed. *Chapt. X.* $\left.\begin{matrix}1.0\text{–}0.5\ CaO\\0.0\text{–}0.5\ Al_2O_3\end{matrix}\right\}$ $0.5\text{–}1.5\ SiO_2 + {}^1/_4Na_2B_2O_4$. 121 frits were prepared by varying the proportion of lime and alumina by 0.05 CaO–0.05 Al_2O_3 and silicification degree by 0.1 in the formulas and were fired to cones 2a, 6a, and 10. Results and discussions are given. **III.** *Ibid.*, **34** [406], 455–65 (1926).—*Chapt. XI.*

Feldspar Group. In the following experiments (except Expt. 9), each set of frits (*A*), (*B*), and (*C*) were compounded so as to form a triaxial diagram of 21 members. Expt. 1. Formulas: (*A*) $NaAlSi_2O_8$ (albite); (*B*) $CaAl_2Si_2O_8$ (anorthite); and (*C*) $KalSi_3O_8$ (orthoclase). Fired to cones 10, 14, and 16. Result: white minute crystals in glaze (*B*). Expt. 2. Formulas: Same as (1), Expt. 1. but $^1/_4Na_2B_2O_4$ added to each glaze. Fired to cones 10, 14, and 16. Result: white obscure crystals in glazes 16 and 17 at cones 14 and 16. Expt. 3. Same as Expt. 1 except that frit $BaAl_2Si_2O_8$ was used for (*C*). White obscure crystals were produced in glaze 5 at cone 16. Expt. 4. Same as the preceding, but $^1/_4Na_2B_2O_4$ added to each formula. Results: (*a*) obscure white radiating crystals found in all glazes containing 0.8 B or 0.4 C at cone 14; (*b*) a remarkable amount of large needle-shaped crystals produced in glazes 9 and 13 and a small amount of them in glaze 6 at cone 16. Expt. 5. Formulas: same as Expt. 2, but $^1/_2$ equivalent of $Na_2B_2O_4$ used instead of $^1/_4$. Fired to cones 8, 10, and 12. Results: (*a*) white minute needles in glazes 16 and 17 at cone 10; (*b*) needles in glazes 16, 11, and 17 at cone 12. Expt. 6. Formulas: same as Expt. 4, but $^1/_2$ equivalent of $Na_2B_2O_4$ used instead of $^1/_4$. Fired to cones 8, 10, and 12. Results: (*a*) fibrous crystals in glaze 3 at cone 8; (*b*) fibrous crystals in glazes 3 and 5, minute needles in (*B*) and minute indefinite crystals in glazes 12 and 17 at cone 10; (*c*) minute needles in (*B*) and glaze 11 and fine fibers in glaze 9 at cone 12. Expt. 7. Formulas: same as Expt. 1, but 0.1 WO_3 added to each glaze. Fired to cones 8, 14, and 16. Results: (*a*) fine granular crystals in glaze 20 at cone 14; (*b*) minute granular crystals in glaze 12 and very minute crystals in glazes 7 and 18 at cone 16. Expt. 8. Formulas: same as Expt. 3, but 0.1 WO_3 added to each glaze. Fired to cones 8, 14, and 16. Result: fine granular crystals in glazes 6, 10, and 20 and minute crystals in glazes 7, 9, 12, and 13 at cone 16. Expt. 9. 33 glazes in $\left.\begin{matrix}1.0\text{–}0.0\ \text{Ab}\\0.0\text{–}1.0\ \text{An}\end{matrix}\right\}$ + (0.25–1.00)CaF_2 were fired to cones 8 and 10. Result: needle-shaped, star-shaped, or obscure crystals produced in 18 glazes fired to cones 8 or 10. Expt. 10. Formulas: same as Expt. 3, but $^1/_2$ CaF_2 added to each. Fired to cones 8 and 10. No crystal produced. *Chapt. XII. Kaliophilite-leucite-orthoclase.* Formulas: 60 glazes with formulas $K_2O \cdot Al_2O_3 \cdot 2\text{–}6\ SiO_2 + 0.25\text{–}0.5\ K_2B_2O_4$ or (0.25 $K_2B_2O_4$ + 0.025–0.10 equivalent of MoO_3, P_2O_5, V_2O_5 or WO_3) were fired to cones 12, 14, and 16. Result: distinct crystals in $K_2O \cdot Al_2O_3 \cdot 6\ SiO_2 + 0.05\ MoO_3 + ^1/_4K_2B_2O_4$ and obscure ones in 30 glazes at cone 14. *Chapt. XIII. Nephelite.* 33 glazes in $m(Na_2O \cdot Al_2O_3 \cdot 2\ SiO_2 + 0.25\ Na_2B_2O_4)$ $n(K_2O \cdot Al_2O_3 \cdot 1\ SiO_2 + 1.25\ K_2B_2O_4)$ were fired to cones 10, 12, and 14. Result: Granular crystals were produced in 8 glazes in which $m = 6\text{–}3.3$, $n = 1$ and $1 = 3$, $m = 3$, $n = 1$ and $1 = 3$ or $m = 4$, $n = 1$ and $1 = 2$ at cone 12. **IV.** *Ibid.*, **35** [415], 331–47 (1927).—In most of the succeeding experiments, frits (*A*), (*B*), and (*C*) were compounded so as to form a triaxial diagram of 21 members. Every glaze was applied on hard biscuited tiles of a porcelain. *Chapt. XIV. Sillimanite.* Expt. 1. Formulas: (*A*) $Al_2O_3 \cdot SiO_2 + ^1/_2Na_2B_2O_4$; (*B*) $Al_2O_3 \cdot SiO_2 + Na_2B_2O_4$; and (*C*) $Al_2O_3 \cdot SiO_2 + ^1/_2Na_2B_2O_4 + ^1/_4MoO_3$. Results: (*a*) crystals produced in almost all glazes at cones 12 and 14, (*b*) needles 3 mm. long observed in (*B*) and its neighbors at cone 14. Expt. 2. Formulas: $Al_2O_3 \cdot 1\text{–}2.5\ SiO_2$ 0·5–1.0 $Na_2B_2O_4$ 0–$^1/_4MoO_3$. Results: (*a*) at cone 14, long needles found in glazes containing only 1 $Na_2B_2O_4$ as flux; (*b*) glazes with 1 SiO_2 most crystallizable. Expt. 3. Glazes: (*A*) calcined kaolin, (*B*) cryolite, and (*C*) fluorspar. Result: Granular crystals in those glazes matured at cone 4a and granular, prismatic, or minute crystals in a few glazes at cone 6a. *Chapt. XV. Danburite.* Formulas: (*A*) CaO B_2O_3 2 SiO_2; (*B*) MgO B_2O_3 2 SiO_2; and (*C*) $\left.\begin{matrix}0.5\ \text{CaO}\\0.5\ \text{MgO}\end{matrix}\right\}$ B_2O_3 2 SiO_2 + 0.5 Na_2SiO_3. No crystal developed. *Chapt. XVI. Rosenbuschite.* Formulas: 6 $CaSiO_3$ 2 $NaZrO_2F_2$ 0.55 ($TiSiO_3TiO_3$) + (0.0–2.0) $Na_2B_2O_4$.

Fired to cones 8, 10, and 12. Minute needles in the glaze without $Na_2B_2O_4$ and less definite crystals in those with the flux. *Chapt. XVII. Hiortdahlite.* Formulas: 4 $CaSiO_3$ $Na_2ZrO_2F_2$ + (0.0–1.0)$Na_2B_2O_4$. Minute needles developed in the glazes with 0.0–0.5 $Na_2B_2O_4$ fired to cones 8, 10, or 12. *Chapt. XVIII. Eudialyte.* Formulas: 2 Na_2O 3 CaO 0.25–2.0 ZrO_2 7 SiO_2. Round, granular, or needle-shaped crystals developed in the glazes with 0.25–1.0 ZrO_2 fired to cones 8 and 10. *Chapt. XIX. Homilite and axinite.* No definite crystal developed. *Chapt. XX. Cordierite.* Formulas: RO Al_2O_3 2.5 SiO_2 where RO = $\left\{\begin{matrix}0.2\text{–}0.5\ \text{FeO}\\ \\ 0.8\text{–}0.5\ \text{MgO}\end{matrix}\right\}$ $\left\{\begin{matrix}0.1\ \text{FeO}\\ 0.1\text{–}0.4\ \text{MnO}\\ 0.8\text{–}0.5\ \text{MgO}\end{matrix}\right\}$ or $\left\{\begin{matrix}0.1\ \text{FeO}\\ 0.1\text{–}0.4\ CaF_2\\ 0.8\text{–}0.5\ \text{MgO}\end{matrix}\right\}$. Scaly, needle-shaped, or minute indefinite crystals observed in the glazes with 0.7 MgO and less fired to cones 14 or 16. *Chapt. XXI. Spinel.* Expt. 1. $\left\{\begin{matrix}1.0\text{–}0.25\ Na_2O\\ 0.0\text{–}0.75\ \text{MgO}\end{matrix}\right\}$ Al_2O_3 $\left\{\begin{matrix}0.5\text{–}6.0\ SiO_2\\ 0.25\text{–}3.0\ B_2O_3\end{matrix}\right\}$. Results: (*a*) $\left\{\begin{matrix}0.81\text{–}0.75\ Na_2O\\ 0.19\text{–}0.25\ \text{MgO}\end{matrix}\right\}$ Al_2O_3 $\left\{\begin{matrix}1.62\text{–}1.50\ SiO_2\\ 0.81\text{–}0.75\ B_2O_3\end{matrix}\right\}$ (cone 16) brilliant with fine fibrous crystals; (*b*) $\left\{\begin{matrix}0.5\text{–}0.25\ Na_2O\\ 0.5\text{–}0.75\ \text{MgO}\end{matrix}\right\}$ Al_2O_3 $\left\{\begin{matrix}2.0\text{–}1.0\ SiO_2\\ 1.0\text{–}0.5\ B_2O_3\end{matrix}\right\}$ and $\left\{\begin{matrix}0.38\text{–}0.25\ Na_2O\\ 0.62\text{–}0.75\ \text{MgO}\end{matrix}\right\}$ Al_2O_3 $\left\{\begin{matrix}2.25\text{–}1.50\ SiO_2\\ 1.13\text{–}0.75\ B_2O_3\end{matrix}\right\}$ (cone 16) mat surfaced with minute transparent crystals. Expt. 2. Formulas: $\left\{\begin{matrix}0.25\ Na_2O\\ 0.25\ CaF_2\\ 0.50\ \text{MgO}\end{matrix}\right\}$ 0.5–1.0 Al_2O_3 $\left\{\begin{matrix}1.0\ SiO_2\\ 0.5\ B_2O_3\end{matrix}\right\}$. Results: (*a*) Glazes with 0.7 Al_2O_3 and more covered with minute needles at cone 16; (*b*) The glaze with 1.0 Al_2O_3 brilliant and developed aventurine effect at cone 16. *Chapt. XXII. Astrophyllite and neptunite.* Expt. 1. Formulas: K_2O.Na_2O 4 RO TiO_2 4 SiO_2 where R = Fe, Mn, and 0.5 Mg in frits (*A*), (*B*), and (*C*) respectively. Obtained 6 fairly good glazes with granular crystals at cone 6a. Expt. 2. Formulas: Na_2O RO TiO_2 4 SiO_2 where R = Fe, Mn and 0.5 Ca 0.5 Mg in frits (*A*), (*B*), and (*C*) respectively. Results: (*a*) Every glaze crystallized at cone 6a; (*b*) 2 excellent and 3 good glazes, all rich in Fe and poor in Mn, at cone 8. *Chapt. XXIV. Titanite.* Expt. 1. Formulas: CaO TiO_2 0–3 SiO_2 0–0.5 $Na_2B_2O_4$. Obtained 6 and 10 fairly good glazes at cones 6a and 8 respectively. Expt. 2. Formulas: CaO TiO_2 0–5 SiO_2. Results: (*a*) CaO TiO_2 changes to needles to cone 12 which grow with rise of firing temperature; (*b*) white amorphous matter appears between the crystals in glazes containing silica; (*c*) Fairly good glazes obtained at cones 14 and 16. Expts. 3–6. Formulas: RO TiO_2 0–3 SiO_2 0–1/4 $Na_2B_2O_4$ where R = Mg, Fe, Mn or Zn. Obtained fairly good results at cones 14 and 16 except Mn glazes. *Chapt. XXV. TiO_2–minerals.* Formulas: TiO_2 + $Na_2B_2O_4$, 0.5 $Na_2P_2O_6$, Na_2WO_4, $NaVO_3$ or Na_2O 1–3 SiO_2. Results: (*a*) needle-shaped crystals in all glazes fired to cones 8–14; (*b*) the crystals longest in the glazes with Na_2O 1–2 SiO_2 fired to cone 14; (*c*) fairly good glazes obtained. S.K.

Synthesis of ash glaze. JIKEI UEDA. *Jour. Jap. Ceram. Assn.*, **34** [400], 191 (1926). —A study on synthesis of various ash glazes is reported. Ash glazes have a fine appearance which cannot be imitated by the use of limestone or talc. One characteristic is the presence of phosphoric acid which tends to opacify and devitrify the glaze and improves its appearance. The actions of the acid are observable when 0.5% is added to glazes. It also prevents underglaze zaffer from flowing. Another characteristic of the glazes is the colors, which may be due to the presence of Fe, Mn, and P. S.K.

Experiments on the Kinuta celadon. TSUNE ISHII. *Jour. Jap. Ceram. Assn.*,

34 [400], 191–92 (1926).—Three hundred and thirty-one glazes were tested with a body, composed of 60 parts Amakusa liparite, 15 feldspar, 25 Gairome clay, and 2 ferric oxide; 3.5 g. of a ground stain which had been prepared by heating a compound ($Fe_2O_3 + 2\,SiO_2$) to cone 11 with reducing flame were added to 100 g. of each glaze. The test pieces were glost-fired to cones 9–10 in a wood-fired kiln. Conclusions: (*a*) the best base glazes are a little more siliceous that the usual porcelain glaze and are apt to be devitrified; (*b*) suitable proportions of their bases is $\left.\begin{matrix}0.5\ K_2O\\0.5\ CaO\end{matrix}\right\}$ or $\left.\begin{matrix}0.6\ K_2O\\0.4\ CaO\end{matrix}\right\}$. Table I shows some of the excellent base glazes obtained.

TABLE I. EXCELLENT BASE GLAZES FOR THE KINUTA CELADON

No.	Limestone	Feldspar	Quartz	Amakusa liparite	Barium silicate
E4	7.73	64.45	27.82	—	—
F8	10.35	55.78	24.70	9.71	—
H14	15.76	32.17	23.48	28.59	—
—	—	48.21	22.89	—	28.90

S.K.

Color imparted to glass by platinum. KITSUZO FUWA. *Jour. Jap. Ceram. Assn.*, **34** [406], 466–74 (1926).—Coloring action of platinum has been investigated by adding a mixture of its chloride and sand to batches of various glasses with or without addition of potassium nitrate, potassium tartrate, or arsenious oxide. Conclusions are: (*a*) glasses are opacified or colored gray by platinum, as it is suspended in them as minute particles; (*b*) no effect is exerted by an oxidizing or reducing agent; (*c*) arsenious oxide acts to coagulate the suspensoid and thereby discourages the coloration. S.K.

Study on the manufacture of ceramic liquid gold. TOSAKU YOSHIOKA AND KENJI NAKANISHI. *Jour. Jap. Ceram. Assn.*, **33** [396], 573–80 (1925).—The manufacture of liquid gold has been studied chiefly following Schwarz's process. Conclusions: (*a*) turpentine or resin is as good as turpentine oil for the manufacture of liquid gold; (*b*) in the preparation of sulphury balsam, too long boiling increases the reducing quality of the product and renders the liquid gold inferior, while that made of sulphury balsam containing free sulphur due to insufficient boiling produces spotted film of gold on firing; (*c*) there is no material difference in the quality of gold sulphury balsam prepared by Schwarz's and Dutertor's processes; (*d*) bismuth added to the liquid gold increases the thermal stability, luster, and adherence of gold film; these actions are encouraged by the presence of cobalt and other metals; (*e*) the reducing quality of turpentine oil can be removed without any loss by exposing it to the sun in an air-tight vessel of quartz glass. S.K.

Gold as a glass colorant. I. KITSUZO FUWA. *Jour. Jap. Ceram. Assn.*, **34** [400], 163–73 (1926).—Gold ruby glass is usually a lead glass to whose batch gold and a reducing agent have been added. The present study has been made for more varieties than the production of ruby glass. (*I*) *Gold and constituents of glass.* A dried mixture of aqua regia solution of gold and pure quartz sand has been added to the batches. The results of the experiments indicate that red glasses are obtained with gold regardless of their constituents, although their effects on intensity and shade of the color are observed. (*II*) *Influence of oxidizing agent on the color.* In general the oxidizing agent tends to intensify the red. (*III*) *Influence of reducing agent on the color.* The reducing agent exerts little effect on the color though it may impart a yellowish tint to some glasses. **II.** *Ibid.*, **34** [401], 213–25 (1926).—(*IV*) *Influence of arsenious acid on the color.* Arsenious acid reduces the intensity of the red color and tends to produce slight greens. (*V*) *Influence of stannic oxide on the color.* Generally speaking stannic oxide intensifies the red, pink or brown given by gold. (*VI*) *Influence of antimony*

oxide. The oxide exerts no particular effect on the color, though the red or pink is intensified in some glasses. (*VII*) *Influence of oxidizing agent and stannic oxide on the color.* The combined effect of an oxidizing agent and stannic oxide resembles that of the latter oxide. (*VIII*) *Influence of reducing agent and stannic oxide on the color.* The effect changes with the compounds of the glasses. In most cases the red color is weakened. **III.** *Ibid.*, **34** [402], 260–72 (1926).—(*IX*) *Influence of arsenious acid and stannic oxide on the color.* The effect of arsenious acid seems to predominate in most cases. (*X*) *Influence of oxidizing agent and antimony oxide.* The development of the red or pink is discouraged, although it is favored in a few instances. (*XI*) *Influence of reducing agent and antimony oxide.* An intermediate effect is observable compared with the glasses containing one of them. (*XII*) *Influence of arsenious acid and antimony oxide.* The effect is rather like that of antimony oxide. **On the coloring action of gold on glass.** *Ibid.*, **35** [413], 214–25 (1927).—(Supplement to the previous study). Colors of various glasses containing gold have been compared before and after reheating them for 1 hr. at 550 or 650°C. Conclusions: (*a*) gold ruby is produced only by reheating; (*b*) reheating at 650°C gives a darker color than that at 550°; (*c*) melt must be stirred in a pot because gold has a tendency of settling down to the bottom; (*d*) the coloration is deeply influenced by chemical composition of glass; the colors of K_2O RO $6SiO_2$ are lighter but clearer than those of Na_2O RO $6SiO_2$; the effect of RO is deeper, *e.g.*, the colors given by 0.01% purple of Cassius on reheating glasses $1.3K_2O$ RO $6SiO_2$ at 650°C were dull purple, slight pink, red, and light pink for BaO, ZnO, MgO, and CaO respectively; the colors of the R_2O B_2O_3 $6SiO_2$ were especially weak; (*e*) gold chloride gives deeper colors compared with purple of Cassius; (*f*) auxiliary material such as tin oxide, antimony oxide, or bone-ash is not necessary, although it affects the colors. S.K.

Coloring glass with silver. I. KITSUZO FUWA. *Jour. Jap. Ceram. Assn.*, **33** [390], 221–35 (1925).—Colors imparted to various glasses by silver chloride which had been added to their batches, the effect of reheating the glasses, and the effect of accessory materials added to the batches are reported. (*I*) *Effect of chemical composition.* Colors produced in soda glass are less clear than those given to potash glass. They are intensified by reheating, the glasses being often opacified by the treatment. No remarkable influence of the difference in RO upon the coloration has been observed. Generally speaking, glasses are colored yellow to brown by 0.01–0.05% Ag and its excess tends to opacify them. (*II*) *Effect of potassium nitrate and potassium tartrate.* Nitrate or tartrate of potash, added to the batches, causes no striking change in the color. **II.** *Ibid.*, **33** [391], 273–96 (1925).—(*III*) *Effect of arsenious acid.* Arsenious acid discourages the coloration by silver. (*IV*) *Effect of* SnO_2. Addition of 0.5–1% stannic acid to the batches has, in most cases, intensified the color produced by silver. (*V*) *Effect of* Sb_2O_3. 0.5–1.0% addition of antimony oxide to the batches had no effect on the color, though it was darkened on reheating in some cases. (*VI*) *Effect of* KNO_3 *and* SnO_2. In most glasses, the combined action of the 2 agents is observed, although the effect of one predominates in some cases. **III.** *Ibid.*, **33** [392], 337–60 (1925).—(*VII*) *Effect of* KNO_3 *and* Sb_2O_3. The colors of silver glasses, to whose batches KNO_3 and Sb_2O_3 had been added, differed, in general, from those of the glasses with or without one of the agents, being distinctly slighter than any case. The same phenomenon was observable on the reheated glasses. (*VIII*) *Effect of potassium tartrate and* SnO_2. The colors resembled, in the main, those given by silver and stannic oxide, though they were a little darker than the latter. (*IX*) *Effect of potassium tartrate and* Sb_2O_3. The constituents of the glasses exert some influence on the coloration, the colors being like those imparted to them when any one of the 2 materials has been employed. The colors of reheated glasses indicate antimony oxide has a stronger influence than the reducing agent. (*X*) *Effect of* As_2O_3 *and* SnO_2, *or* As_2O_3 *and* Sb_2O_3. In both cases,

only the effect of arsenious acid was observable. **On the coloring action of silver on glass.** *Ibid.*, **35** [410], 34–38 (1927).—(Supplement to previous study). Appearances of various glasses containing silver have been compared before and after reheating them for one hour at 550 or 650°C. Conclusions are: (*a*) the intensity of the color imparted by silver depends chiefly upon its diffusibility in the glass which varies with its fusibility; in difficultly fusible glasses, silver is collected as globules on the bottom of the pot; (*b*) true coloration by silver is brought about only after reheating the glass over a certain temperature; (*c*) it ranges from yellow to opalescent yellow and is not uniform, an onyxlike glass being produced in extreme cases. S.K.

On glaze for "Akae" and "Nishikide." MIKIYA AKATSUKA. *Jour. Jap. Ceram. Assn.*, **35** [413], 206–14 (1927).—(*I*) *Introduction.* "Akae" is the general name of oriental overglaze decorations applied thick with transparent glassy colors except red which is opaque and is generally painted thin. In narrow sense, it often means comparatively simple designs of red and another accessory color while complex decorations with several colors are called "nishikide" in Japan and "gosai" in China. The experiments have been done for the purpose of obtaining porcelain glazes which allow stable adhesion of "akae" of wide sense with the colors used for Kutani ware, particular attention being given to their transparency as the decoration is often employed for wares with underglaze blues. (*II*) *The glossy overglaze colors.* The colors are prepared by mixing lead and 2–5% coloring oxides to frits. (*III*) *Experiments and their results.* Glost-fired small flat vases made of a body, which was composed of 65 Amakusa liparite, 15 feldspar, and 20 Gairome clay, and had a formula of $1KNaO \cdot 4Al_2O_3 \cdot 24SiO_2$, were painted with the colors and were fired to 870–880°C. Of numerous glazes the following have proved to be most excellent. For wares with underglaze colors: $\left.\begin{matrix}0.3\ KNaO \\ 0.7\ CaO\end{matrix}\right\} 0.85\ Al_2O_3 \cdot 9.5\ SiO_2$, $\left.\begin{matrix}0.4\ KNaO \\ 0.6\ CaO\end{matrix}\right\} 0.8\ Al_2O_3 \cdot 10.0\ SiO_2$, $\left.\begin{matrix}0.4\ KNaO \\ 0.6\ CaO\end{matrix}\right\} 0.85\ Al_2O_3 \cdot 9.5\ SiO_2$, and $\left.\begin{matrix}0.5\ KNaO \\ 0.5\ CaO\end{matrix}\right\} 0.8\ Al_2O_3 \cdot 9.0\text{–}10.0\ SiO_2$. For ware without underglaze color: $\left.\begin{matrix}0.3\text{–}0.4\ KNaO \\ 0.7\text{–}0.6\ CaO\end{matrix}\right\} 0.85\ Al_2O_3 \cdot 10.5\ SiO_2$ and $\left.\begin{matrix}0.5\text{–}0.6\ KNaO \\ 0.5\text{–}0.4\ CaO\end{matrix}\right\} 0.85\ Al_2O_3 \cdot 9.5\ SiO_2$. They should be fired to cones 11–13, cone 12 being most desirable. (*IV*) *Considerations on the results.* (*a*) The thermal expansions of the colors are greater than those of ordinary porcelains and their glazes. The stable adhesion of the colors owes to favorable composition and state of fusion in some glazes. (*b*) The stable adhesion is favored by insufficient fusion of the glazes and the colors which increases their elasticity. (*c*) Lime glazes rich in silica and alumina make the adhesion stable since they have strong tendencies of producing intermediate layers between bodies, glazes and colors. S.K.

BOOKS

Maya Cities. THOMAS GANN. London: Duckworth and Co., Ltd., 1927. Price 21*s*. The newly excavated temples, decorated in brilliant colors, date back thousands of years. The book contains 54 illustrations. H.H.S.

Guide to the Belgium Museums. A. J. DELEN AND RENÉ LECLERCQ. With preface by Jules Destrée. Translated from French by H. Tuck Sherman. xxxi+291 pages. London: Methuen and Co., 1927. Price 7*s* 6*d*. Museums and churches, profusely illustrated and with an introduction on plastic art in Belgium by D. who is assistant curator of the Plantin-Moretus Museum. H.H.S.

Drinking Vessels of Bygone Days. G. J. MONSON-FITZJOHN. London: Herbert Jenkins, Ltd., 1927. Price 7*s* 6*d*. H.H.S.

English Delft Pottery. R. G. MUNDY. 120 illustrations. London: Herbert Jenkins, Ltd., 1927. Price 25*s*. Edition *de luxe*, limited to 100 numbered copies, price 3 guineas. H.H.S.

PATENTS

Ceramic and method of making the same. LYNN B. BERNHEIM. U. S. 1,654,401, Dec. 27, 1927. A ceramic ware having a crazed glaze, the minute cracks of which are filled with different colored material.

Method of decorating glassware and article produced thereby. EDWARD A. ZEH. U. S. 1,656,260, Jan. 17, 1928. In the art of affixing a colored label to a clear glass bottle, the method which consists in positioning a thin background forming coating of a metallic color on the clear glass surface, the coating having the outline configuration desired of the completed label, subjecting the bottle with such coating to a firing treatment for a short period of time and at a temperature sufficiently high to fuse the background firing color gently to the face of the glass, positioning on the background thus formed a decalcomania of the desired label located accurately with relation to the outlines of the background and formed of a plurality of metallic colors contrasting with the color of the background and subjecting the same to a second firing treatment to fuse the decalcomania design to the background design.

Cement, Lime, and Plaster

Further studies on Portland cement compounds by the X-ray diffraction method. W. C. HANSEN. *Jour. Amer. Ceram. Soc.*, **11** [2], 68–78 (1928).—In this investigation a study has been made of methods for preparing compounds of CaO with Al_2O_3 and SiO_2 which may occur in Portland cements. The products from the different methods were studied microscopically and by the X-ray diffraction method, and the X-ray diffraction patterns for γ and β $2CaO \cdot SiO_2$ and $3CaO \cdot SiO_2$ are given.

Manufacture of lime. ANON. Bur. Stand., *Circ.*, No. 337, (1927).—An account of the methods employed in the manufacture of quicklime and hydrated lime at various plants and includes a description of 9 plants which were visited. Difficulty having been experienced in specifying the lime best suited for use for a particular purpose in terms other than those of trade names, it was desired if possible to secure such knowledge relative to the products of the various lime kilns of the U. S. as would indicate either by their source or by investigations of the chemical and physical properties of the resulting products which kind of lime would be most efficient and economical for each particular use. It is the object of this paper to compare the equipments of the various plants and processes, with special reference to economy of operation and quality of the finished product. The results of some laboratory work have been included in the discussion in order to throw more light on some of the points. The comparative heat efficiency attained by the use of different methods of creating the draft was deemed of sufficient importance to warrant an investigation. R.A.H.

Effect of wetting on the adhesion of gypsum plaster to gypsum plaster board. ANON. Bur. Stand., *Tech. News Bull.*, No. 128, p. 4, (1927).—Previous work demonstrated the fact that the bond between gypsum plaster board and properly applied sanded gypsum plaster is sufficiently great to allow of plaster board being used as a backing for plaster in ordinary construction work. The Bureau has undertaken a series of tests on the effect of wetting of these plaster backings and the results of these tests indicate that while wetting weakens the bond between gypsum plaster and gypsum plaster board, the full adhesive strength is regained as the materials again become dry. R.A.H.

Manufacture of gypsum plasters. W. B. LENHART. *Rock. Prod.*, **30** [25], 42–44 (1927).—The common mineral impurities associated with gypsum are: Anhydrite

($CaSO_4$) or gypsum minus the water of crystallization, calcium carbonate, sodium chloride, elemental sulphur, gypsite, and siliceous substances. The surface materials which in some cases are badly leached and spongy by nature commonly called "sugar gypsum" can be classed as an impurity along with gypsite when considered with rock gypsum. The effect of each of these impurities on the plaster is discussed. F.P.H.

Expansion of neat Portland cement in steam. ANON. *Rock Prod.*, **30** [25], 57 (1927).—An investigation was made by the Bureau of Standards of the volume changes produced in various Portland cements when neat cement specimens were subjected to steaming and boiling tests. Data were secured on 32 different cements when tested by the following 4 methods: (*a*) The regular specification test, 5 hours steaming of cement pats; (*b*) the Le Chatelier tongs test, involving 6 hours boiling; (*c*) bars, 1 x 1 x 6 in., steamed 5 hours, and measured by a special micrometer, bearing against glass inserts in ends of bars; (*d*) identical bars and treatment as in preceding test, but measurements made microscopically by comparator, using glass capillary tubing inserts for markers. The neat cement bars were stored in a constant temperature cabinet, maintained at 21°C (70°F) prior to test and for one hour after their removal from the steam, when the final measurement was made. No deductions are herein made as to the relative merits of these cements, as indicated by the results of these tests. The following brief observations are interesting: (1) The usual specification test of the neat cement pats did not give any indications of the relative expansion properties of the cements. All of the cements were "sound." (2) The Le Chatelier tongs did not give very concordant results, nor did the results seem to agree very closely with those obtained by methods (*c*) and (*d*). (3) Test method (*c*) showed that the expansion of none of the cements was great compared with what might be expected of those cements which would prove to be "unsound" in the specification tests of pats. The tests of the bars, however, did show that the relative expansion properties of some of the 32 cements varied widely, being grouped as follows:

Group	No. of cements in group	Expansion obtained (per cent)
1	7	.000–.010
2	12	.011–.020
3	7	.021–.030
4	5	.031–.040
5	1	.061

(4) In general, the results of method (*c*) were confirmed by method (*d*), but the latter method did not give such concordant results for individual tests as (*c*), notwithstanding the more elaborate and precise nature of the comparator. It is thought that slight warping of occasional specimens may have greatly disturbed the relative directions of the glass tubing inserts. Method (*d*) was much more difficult and consumed more time than method (*c*). (5) The foregoing is based on the tests of cement mixed to a "normal consistency." The series of tests was then repeated, using a wetter mix, containing 42% water (per cent by weight of cement). The results obtained confirmed the observations made on the specimens of normal consistency, although some slight changes would be produced in the grouping as given above. F.P.H.

Mixing and blending dry raw materials for Portland cement manufacture. ANON. *Rock Prod.*, **30** [26], 162–65 (1927).—Pulverized, dry, cement raw materials of varying physical and chemical characteristics are being mixed and blended by means of the Fuller-Kinyon conveying system with very little additional equipment other than that normally required for conveying from finish mills to raw storage and from raw storage to kiln tanks. Due to the ease with which the transport lines can be interconnected, almost any desired combination can be arranged for making a system equally as well applicable to old as to new plants. In the first few installations placed in commercial

service mixing and blending was accomplished under manual control, *i.e.*, manual operation of the diverting valves. The success of these installations in improving the quality of the cement and effecting savings in lost kiln hours by eliminating kiln feed flushing, and by preventing the formation of clinker rings due to improperly mixed feed, as well as the more convenient distribution of the materials led to the development and installation of the automatic time-controlled blending system, which is now being installed in a number of new and old cement plants. The automatic system has substantially eliminated manual control and placed the entire system and its control under the direct supervision of the plant chemist. F.P.H.

Filtration of cement slurry. D. C. COULSON. *Rock. Prod.*, **30** [26], 165–68 (1927).—Filters demonstrated greater output and lower fuel consumption from wet-process cement kilns. In short, kilns operated on filter slurry cake have the advantage of high capacity and low fuel comsumption of the dry process and retain all the advantages of wet process, which are: (1) Better and more uniform cement due to better mixture of materials and closer chemical control. The development of the dry blending system requiring a number of bins and complicated handling equipment for the dry mix has partially offset this advantage. (2) Wet material is more easily ground resulting in lower costs and requiring less plant investment. (3) Raw material need not be dried, saving fuel and equipment. (4) Due to items (1) and (2) clinkers not burned so hard and therefore grind easier, resulting in better cement at less cost. (5) Mechanical handling of wet slurry is easier than dry mix. (6) There is less dust in plant; more healthful working conditions and better labor efficiency. F.P.H.

Petrography and Portland cement manufacture. WM. A. FORBES. *Amer. Iron Steel Inst.*, Advance Paper, N.Y. Meeting, pp. 30–32 (1927).—The quality of cement depends on the relative proportions of a series of compounds of Ca, Si, and Al, which are not easily determinable by chemical analysis, but require the service of petrographic or X-ray methods. At present X-ray methods are adapted only to research and are not suitable for plant use. Samples require too long for preparation, and are not sufficiently representative of the material. But during the last 2 or 3 years the petrographic microscope has become a practical and much-used instrument. Its most important use is to determine the degree of burning which the clinker has received, but it also verifies chemical analysis, and is quicker, cheaper, and often more accurate than analysis. H.H.S.

Fineness of cement. WM. A. FORBES. *Amer. Iron Steel Inst.*, Advance Paper, N.Y. Meeting, p. 32 (1927).—The demand for cement of ever higher quality has resulted in extensive tests to determine all the factors which influence strength. One of these is fineness. The standard specification limits the residue on a 200-mesh sieve to 22%, but this gives no indication of the fineness of that portion which passes through. An air analyzer was designed to separate this fine material into 4 fractions. The finest was found to have a separation size of 8.9 microns, equivalent to a 2200-mesh. H.H.S.

Influence of carbonic acid on the rate of setting of Portland cement. ITSUO YAMAZAWA AND TATSU KIYODA. *Jour. Jap. Ceram. Assn.*, **34** [402], 291–92 (1926).—Y. and K. investigated the flash set of Portland cement. Conclusions: (*a*) development of the flash set is caused probably by its absorption of carbonic acid; (*b*) Portland cement containing about 1.4% of SO_3 remains slow setting after absorption of the gas; (*c*) the absorption of carbonic acid attains its maximum at about 2% of the cement. S.K.

Setting and electrical conductivity of Portland cement. SHUZO AKASHI. *Jour. Jap. Ceram. Assn.*, **34** [403], 321–25 (1926).—A. describes his preliminary work on the relation between setting and electrical conductivity of Portland cement. S.K.

Methods of calculating average strengths in cement tests. KOZO FUJII. *Jour. Jap. Ceram. Assn.*, **34** [404], 371–88 (1926).—General descriptions and discussions on various

methods of calculating average strengths in cement tests are given with mathematical formulas and examples. S.K.

Reducing water content of cement slurries. YUJI TAKAMATSU. *Jour. Jap. Ceram. Assn.*, **35** [409], 6–9 (1927).—The effect of adding varying amounts of sodium carbonate up to 40% of the raw cement mixture to Portland cement slurries containing 30–35% of water on their viscosity has been determined with the result that the maximum fluidities are given with about 3% alkali regardless of the water content. S.K.

Manufacture of slaked lime with steam. KIYONOBU KISHIMOTO. *Jour. Jap. Ceram. Assn.*, **35** [411], 109–15 (1927).—Influence of temperature and vapor pressure in the manufacture of slaked lime on the chemical activity of the product has been experimented. Conclusions are: (*a*) the rate of hydration is accelerated by increasing vapor pressure; (*b*) it tends to fall with rise of the temperature provided that the vapor pressure remains constant; (*c*) the chemical activity of slaked lime prepared by natural hydration or hydrated at temperatures below 30°C is greater when the vapor pressure has been lower; (*d*) slaked lime which is as active as the best one prepared by natural hydration can be quickly obtained by hydrating lime with vapor at a temperature of 45°C and up. S.K.

New accelerated test for soundness of Portland cement. BUNSHI YOKOYAMA. *Jour. Jap. Ceram. Assn.*, **35** [411], 107–108 (1927).—Y. proposes a quick test for the constancy of volume of Portland cement as follows: A paste of normal consistency is molded into Le Chatelier's caliper. It is placed between a plate and a cover of glass and is allowed to remain 2 hrs. at 15–25°C. Then it is put in an air bath and kept at 35–40°C for 4 hrs., and heated in boiling water for 20 min. To pass the test satisfactorily, the expansion should not exceed 3 mm. S.K.

Effect of calcium chloride on some physical properties of Portland cement. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **4**, 1–9 (1926).—The effect of calcium chloride on the time of setting and strength of Portland cement has been investigated. Conclusion: (*a*) Calcium chloride when used within certain limited proportions accelerates the setting and hardening of the cement and increases the tensile strength of the neat or sanded cement. S.K.

Refractoriness of Portland cement and its mortar. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **4**, 11–20 (1926).—Refractoriness of Portland cement, its mortar and various building materials has been determined. Some of the results are as follows: 1:3 mortar of Asano cement and fine sand of Hirose river 1329°C; coarse sand 1312°; sand of Tamagawa river 1354 or 1425°; average of 14 Japanese cements 1412°; gravel of Hirose river 1197–1466°. S.K.

Thermal analysis of Portland cement: its raw materials and its product of hardening. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **5** [1], 15 pp. (1926).—The changes in weights of Portland cement, its raw materials, and its product of hardening in heating have been observed with a thermobalance. (1) *Limestone.* The decomposition of the mineral commences at 600°C, becomes vigorous at 690° and ends at 700°. (2) *Clay.* (3) *Clay slate.* (4) *Gypsum.* A sudden change in weight takes place at 104°. The loss is completed at 660°. (5) *Portland cement.* (6) *Hardened cement.* The weight change takes place in 3 stages. The first change occurring at about 100° is due to expulsion of mechanical water while the others taking place at about 400 and 600° are due to the decomposition of hydroxide and carbonate of calcium respectively. S.K.

Thermal analysis of cement-admixtures and mixed cements. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **5** [2], 264–82 (1926).—The weight changes which occur in heating cement-admixtures, such as diatomaceous earths, volcanic ashes, acid clays, mixed cements, such as Soliditit and slag cement, hardened Soliditit and the

products of hardening of mixed cements composed of Portland cement and diatomaceous earths, volcanic ashes, or acid clays have been observed with a thermobalance.

S.K.

Melting point curves of limestone-clay mixtures. I. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, 5 [2], 283–304 (1926).—Melting point curves of mixtures of limestones and clays used for the manufacture of Portland cement are given, the melting point being determined by the bending of cones made of the mixtures. (1) The average of the 21 experiments comprising 15 limestones and 17 clays are shown (Tables I and II).

TABLE I

Chemical Analysis of Limestones and Clays

	Silica	Alumina	Ferric and ferrous oxide			
15 limestones	0.05– 0.80		0.08– 0.38			
17 clays	44.02–75.74	10.70–30.72	2.20–11.20			
Lime	Magnesia	Soda	Potash	Carbon dioxide	Insol. ratio	
54.40–56.08	0.17– 0.97	0.00– 0.20		43.39–44.08	0.06– 1.35	
0.00– 6.76	0.65 –3.92	0.00–2.16	0.00–5.62	—	—	
Manganous oxide	Loss on ignition					
—	—					
0.00– 0.15	0.70–11.08					

TABLE II

MEAN MELTING POINT

Limestone (%)	100	95	90	85	80	75	70	65	60	55	50
Clay (%)	0	5	10	15	20	25	30	35	40	45	50
Melting point (°C)	1914	1892	1846	1771	1710	1632	1541	1424	1357	1309	1280
Limestone (%)	45	40	35	30	25	20	15	10	5	0	
Clay (%)	55	60	65	70	75	80	85	90	95	100	
Melting point (°C)	1268	1259	1252	1253	1259	1273	1299	1332	1378	1426	

(2) The proportions of limestone and clay in the mixtures corresponding to Portland cement range from 6.5:3.5 to 7:3, most of them being nearer to the latter than to the former. The 7:3 mixtures melt at temperatures ranging from 1437–1660° while the range for 6.5:3.5 mixtures is 1285–1580°. (3) An addition of iron ore to a clay causes a marked reduction in the refractoriness of its mixture with a limestone. Tables III and IV show such an effect on the mixtures of limestone I, containing 0.80 SiO_2, 0.38 Al_2O_3, Fe_2O_3, and FeO, 54.40 CaO, 0.97 MgO, 0.17 NaKO, 43.59 CO_2, and 1.11 insolubility residue, and clay B, containing 70.92 SiO_2, 10.70 Al_2O_3, 2.96 Fe_2O_3, and FeO, 3.92 MgO, 0.96 CaO, 1.86 Na_2O, 2.02 K_2O 6.05 loss on ignition, and 0.08 MnO.

TABLE III

Melting Points of Mixtures of Limestone I and Clay B

Limestone (%)	100	95	90	85	80	75	70	65	60	55	50
Clay (%)	0	5	10	15	20	25	30	35	40	45	50
Melting point (°C)	1920	1920	1880	1825	1740	1650	1530	1415	1410	1407	1415
Limestone (%)	45	40	35	30	25	20	15	10	5	0	
Clay (%)	55	60	65	70	75	80	85	90	95	100	
Melting point (°C)	1408	1397	1388	1381	1357	1356	1377	1397	1435	1444	

TABLE IV

Effect of Iron Ore Admixed to Clay B on the Melting Point of Its Mixtures with Limestone I

Limestone (%)	85	80	75	70	65	60	
Clay (%)	15	20	25	30	35	40	
Melting point (°C) Clay B with 1% iron oxide	1680	1640	1580	1451	1331	1325	
" " " 1.5% " "	1610	1560	1550	1428	1256	1337	
" " " 2% " "	1600	1550	1500	1411	1376	1327	

S.K.

Influence of mica on the strength of cement paste and mortar. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **5** [2], 305–309 (1926).—Any addition of biotite or muscovite to a Portland cement paste or mortar causes marked reduction in its tensile strength. The reduction increases with the amount of mica. S.K.

Influence of Japanese acid clays on the strength of Portland cement. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **5** [2], 313–17 (1926).—Any addition of Japanese acid clay to 1:3 Portland cement mortar reduces its tensile and compressive strengths. The influence is comparatively strong when the admixture exceeds 5%. S.K.

White Portland cement. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **5** [2], 318–21 (1926).—The white Portland cement manufactured by the Onoda Cement Co. is not stronger than ordinary Portland cements made in Japan. S.K.

On the melting point curves of Portland cement and admixtures. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **5** [2], 322–29 (1926).—The melting point curves of the mixtures composed of 100–0 Portland cement and 0–100 volcanic ash, acid clay, diatomaceous earth or granite, or 100–0 Soliditit and 0–100 diatomaceous earth or acid clay are given. S.K.

Marine experiments of Portland cement, mortar, and concrete. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **5** [2], 328–45 (1926).—Strengths of test pieces made of Portland cement, mortar, or concrete and stored in sea-water tank, are compared with those of similar test pieces submerged in seashore exposed to the impact of waves (Tables I, II, III).

TABLE I. STRENGTH OF 1:3 MORTAR

	Tensile strength (kg./sq. cm.)					Compressive strength (kg./sq. cm.)				
	7 d.	28 d.	90 d.	180 d.	360 d.	7 d.	28 d.	90 d.	180 d.	360 d.
Stored in seashore	23.63	27.94	27.30	27.59	29.13	300.9	360.6	408.0	406.5	415.9
Stored in sea-water tanks	20.92	23.25	28.00	34.33	36.50	284.3	321.4	466.9	466.9	471.4

TABLE II. COMPRESSIVE STRENGTH OF 1:2:4 CONCRETE

	Compressive strength (kg./sq. cm.)					
	7 d.	14 d.	28 d.	90 d.	180 d.	360 d.
Stored in seashore	265.9	241.7	240.3	302.2	305.5	334.2
Stored in sea-water tanks	253.7	240.9	274.5	335.4	337.2	345.8

TABLE III. TENSILE STRENGTH OF 1:3 MORTAR (cement = 0–5 % volcanic ash)

Volcanic ash (%)	Age in days	Tensile strength (kg./sq. cm.) Stored in seashore	Stored in sea-water tanks
0	28	26.04	21.90
0	360	32.75	35.42
1	28	29.90	22.14
1	360	34.50	31.27
2	28	29.77	24.13
2	360	36.68	38.13
3	28	27.04	22.50
3	360	39.63	27.85
4	28	29.19	27.85
4	360	37.91	40.07
5	28	27.25	24.16
5	360	36.99	38.52

Theoretical considerations are given with microphotographs of set and hardened cements with or without admixture of gypsum. S.K.

Binary and ternary diagrams of CaO, SiO_2 and Al_2O_3. I. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **5** [3], 1–28 (1927).—*(1) Preliminary study of binary systems.* Melting points curves of SiO_2–Al_2O_3, SiO_2–CaO, and CaO–Al_2O_3 binaries

are given. (*2*) *Preliminary study of the ternary system CaO–SiO_2–Al_2O_3.* Melting point of 86 members in the system are given with a diagram. (*3*) *Thermal analysis of hydrated calcium aluminates.* The weight changes which occur in heating hydrated $CaO \cdot Al_2O_3$, $3CaO \cdot 5Al_2O_3$, $5CaO \cdot 3Al_2O_3$, and $3CaO \cdot Al_2O_3$ have been determined. (*4*) *Setting and hardening of calcium aluminates.* Experiments on the setting and hardening of the aluminates are described (Table I).

TABLE I

	$CaO \cdot Al_2O_3$	$3CaO \cdot 5Al_2O_3$	$5CaO \cdot 3Al_2O_3$	$3CaO \cdot Al_2O_3$
Calcium aluminates	3:5	1:1	5:3	3:1
Temp. rise in hydration (°C)	2.0	19.0	43.3	52.2
Time of the maximum rise (min.)	4	3	4.5	4
Final set (hr.-min.)	2–38	0–47	3–30	2–15
Soundness	sound	sound	cracked	disintegrated
Compressive strength				
At 1 hr. (kg./sq. cm.)	12.00	70.50	4.20	2.00
At 2 hrs. "	20.50	80.25	4.98	22.80
At 24 hrs. "	110.00	93.00	—	83.60

(*5*) *Expansion of calcium aluminates.* Linear changes on heating the aluminates from room temperature to about 1000°C are reported. (*6*) *Microscopic study.* Descriptions are given on the changes which take place in the hydration of the aluminates with microphotographs. S.K.

Temperature rise during the setting of Portland cement containing calcium chloride. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **6** [1], 1–7 (1927).—(*1*) *Neat cement pastes.* Temperature rise and time from gaging the maximum temperature rise or final set of the pastes, each composed of 300 g. of a Portland cement, consisting of silica 22.06, lime 62.90, ferric oxide and alumina 10.38, magnesia 2.20, sulphuric anhydride 1.47, and loss on ignition 0.63; 0–20% calcium chloride with 75% purity and 30% water, have been measured (Table I).

TABLE I

	Per cent of calcium chloride								
	0	1	2	2.5	3	5	7	10	20
Final set (hr.-min.)	13–22	8–30	6–20	5–33	5–24	3–40	2–30	1–18	1–6
Temperature rise (°C)	24.2	40.0	40.5	42.0	41.3	38.1	40.8	50.7	57.5

The maximum strength has been developed with 2.5% calcium chloride. (*2*) *Mortars with 3% calcium chloride.* Similar results are reported. S.K.

Thermal analysis of mixed cements. SHICHIRO UCHIDA. Sendai Higher Tech. School, *Research Rept.*, **6** [1], 7–8 (1927).—Weight-losses which occur in heating hardened pastes composed of a Portland cement and 3–10% calcium chloride or 5–10% antifreezing agent, consisting of CaO 34.94, MgO 3.27, NaCl 3.27, SO_3 13.93, ignition loss 18.90, insoluble matter 0.38, and P_2O_5 0.05, have been determined with a thermobalance. S.K.

Hydration of ternary systems CaO-Al_2O_3-SiO_2. SHICHIRO UCHIDA AND YOSHIAKI SANADA. Sendai Higher Tech. School, *Research Rept.*, **6** [1], 9–22 (1927).—Seventy-eight mixtures within the ranges of 0–80% alumina, 0–60% silica, and 15–85% lime were studied. Each mixture was ground in an agate mortar, kneaded with water, and then formed into a 1-cm. ball. The ball, after drying gently, was placed on a disk of same material in an electric furnace and heated to melting. A small quantity of the sample taken from the ball was ground very fine and placed on a clean slide glass. A drop of distilled water was added to the sample and covered with a cover glass. It was then sealed with paraffin and was stored in a thermostat at 25°C observing from time to time under a microscope. The 78 microphotographs and a triaxial diagram, in which

boundaries between (*a*) compositions which hydrate and those which do not hydrate, (*b*) those hydrating in colloidal form and those hydrating in crystals, and (*c*) those hydrating in needle-shape and those hydrating in solid form are shown. Discussions are given. S.K.

Tables of tests on a cement and arbitrary cements by 32 laboratories. *Jap. Soc. Port. Cement Mfg.*, Sept., 3 pp. (1927).—A test-sample of a Portland cement OmY was sent by the society to every member-factory to be tested in order to know how the results would compare. The members were also requested to test another cement. The results are shown in Tables I and II.

TABLE I

Results of Tests of Cement OmY by 30 Member-factories (Sept. 13–27, 1927)

	Tensile strength (kg./sq. cm.)				Compressive strength	
	Neat	1:3 mortar			1:3 mortar	
	1 w.	3 d.	1 w.	4 w.	3 d.	1 w.
Range	55.7–73.6	20.9–34.8	27.0–37.0	32.1–42.5	150.8–426.0	223.6–490.0
Average	67.1	28.9	32.0	37.7	330.2	404.1
	(kg./sq. cm.)	Time of setting (hr.–min.)			sp. gr.	Fineness
	4 w.	Initial set	Final set		Not ignited	Residue on 4900-sieve
	337.4–609.0	1.51–3.30	3.00–6.13		3.60–3.185	2.00–8.50
	486.0	2.31	4.18		3.136	3.93
	Ig. loss	Insol. ratio	Silica	Alumina	Ferric oxide	Lime
	0.71–1.48	0.06–0.74	21.07–23.39	4.94–6.48	2.47–3.95	64.03–65.67
	1.25	0.29	22.30	5.61	2.99	64.96
	Magnesia	SO_3	Total			
	0.46–1.59	0.79–1.62	98.50–100.73			
	1.12	1.23	99.69			

TABLE II

Results of Tests Made on 27 Japanese Portland Cements.

	Tensile strength (kg./sq. cm.)				Compressive strength (kg./sq. cm.)	
	Neat	1:3 mortar				
	1 w.	3 d.	1 w.	4 w.	3 d.	1 w.
Range	60.6–83.8	23.5–33.5	26.0–38.5	33.6–42.5	204.8–457.0	256.0–539.0
Average	73.6	28.9	32.7	38.0	335.6	409.7
		Time of setting (hr.-min.)			sp. gr.	Fineness
	4 w.	Initial set	Final set		Not ignited	Residue on 4900 sieve
	306.2–669.0	1.20–3.36	2.15–5.16		3.090–3.197	1.40–11.80
	497.8	1.59	3.31		3.142	4.19
	Ig. loss	Insol. ratio	Silica	Alumina	Ferric oxide	Lime
	0.78–1.56	0.00–0.92	20.50–24.38	4.25–7.49	2.50–4.83	63.15–65.80
	1.17	0.43	22.12	5.69	3.27	64.48
	Magnesia	SO_3	Total			
	0.50–2.06	0.99–1.80	98.34–100.45			
	1.21	1.31	99.58			

S.K.

Tests on quick-hardening cements. Lab. of Civil Engineering, *Research Rept.*, No. 4, 72 pp. (1926).—Physical properties of 4 quick-hardening cements are compared with those of an ordinary Portland cement manufactured by the Asano Cement Co. (*1*) *Outline of tests.* (*2*) *Tests on neat and mixed cements.* Specific gravity, fineness, time of setting, soundness, and strength of the cements have been tested (Table I).

TABLE I

PHYSICAL PROPERTIES OF THE CEMENTS

Cements	Specific gravity	Residue on No. 200 sieve	Tensile Strength of Neat Cement (kg./sq. cm.)					
			1 d.	2 d.	3 d.	1 w.	4 w.	13 w.
(*a*) Ciment fondu	3.02	8.51%	55.9	85.7	84.7	65.9	92.2	86.0
(*b*) Atlas Lumnite cement	3.13	4.40%	56.4	105.2	96.3	72.9	97.8	86.7
(*c*) Dyckerhoff doppel	3.14	4.15%	31.1	45.5	73.1	75.2	80.9	84.3
(*d*) Rapid hardening ferro-concrete	3.07	0.65%	26.0	36.6	52.3	57.5	79.8	72.8
(*e*) Asano Portland cement	3.14	5.93%	19.1	26.1	34.6	48.6	69.3	76.1

(*3*) *Tests on mortars.* Strength of 1:3 mortars with a river sand at Yorii is reported (Table II).

TABLE II

	Cement tensile strength of 1:3 mortar (kg./sq. cm.)					Compressive strength of 1:3 mortar (kg./sq. cm.)				
	1 d.	2 d.	3 d.	1 w.	4 w.	1 d.	2 d.	3 d.	1 w.	4 w.
(*a*)	45.4	52.9	62.3	62.1	60.2	487	568	575	606	624
(*b*)	45.8	50.0	60.2	41.5	62.7	402	505	567	644	615
(*c*)	10.8	19.9	34.2	48.8	58.2	91	151	240	366	550
(*d*)	10.4	19.2	35.8	53.0	57.6	77	144	207	388	405
(*e*)	3.7	7.9	17.5	33.1	47.2	32	61	83	189	350

(*4*) *Compressive test on concrete.* Compressive strength of concrete composed of 1 volume of cement, 2 volumes of sand (0–1/4 in.) and 4 volumes of crushed granite (1/4 in–1 in.) has been tested (Table III).

TABLE III

COMPRESSIVE STRENGTH OF 1:2:4 CONCRETES

Cement	water used in per cent of otal solid mixture by weight	Compressive strength (kg./sq. cm.)					
		1 d.	2 d.	3 d.	1 w.	4 w.	13 w.
(*a*)	8.3	126	204	251	273	315	314
(*b*)	7.4	119	162	212	196	354	382
(*c*)	7.9	16	46	67	137	286	382
(*d*)	8.3	10	26	54	161	279	311
(*e*)	7.4	6	16	30	89	189	320

S.K.

Enamels

Acid-resistant enamels. A. MALINOVSZKY. *Jour. Amer. Ceram. Soc.*, **11** [2], 110–13 (1928).—The qualities of an acid-resisting enamel are enumerated. Kerstan's formulas are given and results of tests made on the enamels of these formulas are discussed.

Controlling the consistency of enamel slips. W. N. HARRISON. Bur. Stand. *Tech. Paper*, No. 356 (1927).—Published in *Jour. Amer. Ceram. Soc.*, **10** [12], 970–94 (1927). For abstract see *Ceram. Abs.*, **11** [1], 12 (1928).

Improvements in pickling: inhibitors. WM. A. FORBES. *American Iron and Steel Inst.*, Advance Paper, N.Y. Meeting, pp. 60–61,72–74 (1927).—Pickling with H_2SO_4 or HCl may be accompanied by undesirable effects such as excessive loss of material, local pitting of surfaces, and absorption of H. In the case of sheet steel, where the ratio of surface to volume is extremely high, and where the voids in the ingot are always elongated, control of pickling is of special importance. The primary factors are time of immersion, strength of acid, and temperature of solution; but the presence of certain additional agents, or inhibitors, greatly modifies the relationships between time, temperature, and concentration, and it is possible by a knowledge of these changes to select the most advantageous conditions, particularly in regard to H. It had been shown that H was capable of passing entirely through the metal, and that when it met with internal discontinuities, molecular H_2 might be formed which tended to form blisters, or to be retained by the metal and become a factor in subsequent operations. The presence of inhibitors (the nature of which is not specified) reduces the absorption of H to a minimum and produces a smooth, clean surface with economy of material. H.H.S.

Technological problems of the steel industry. WM. A. FORBES. *Amer. Iron and Steel Inst.*, Advance Paper N.Y., Meeting, 89 pages (1927).—F., who is assistant to the president of the U.S. Steel Corporation, describes the major problems of ferrous metallurgy, from the mining and beneficiation of the ore to assisting customers. Of especial ceramic interest, apart from fuels and furnaces, are: (1) the manufacture of cement from blast-furnace slag, the petrography of cement, and the recovery of high-phosphorous fertilizer slag, (2) the pickling of iron and sheet steel, and a method of cleaning systems

when clogged with rust and scale, (3) annealing, and (4) the manufacture of artificial grinding wheels. H.H.S.

Manufacture and application of vitreous enamels. W. MAVOR. *Chem. and Ind.* **46,** 1149 (1927).—A popular lecture at the University Club, Ottawa, on white and colored enamels. H.H.S.

Cast-iron Research Assn. H. B. WEEKS. *Chem. and Ind.*, **46,** 1153 (1927).—The long protracted coal dispute in England caused several withdrawals from membership particularly among small foundries. This was particularly unfortunate in view of the highly satisfactory report made by the Government Department of Science and Industrial Research on the first five years working of the Association, which has no capital endowment and works entirely from income. The new president is Sir Philip Nash, succeeding Sir John Dewrance. H.H.S.

Glass

Loss of silica during glass melting. S. R. SCHOLES. *Jour. Amer. Ceram. Soc.*, **11** [2], 79–80 (1928).—Repeated analyses of glass taken from an operating tank at different times show that, when round-grained and dustless sand is used, the silica found in the glass averages 0.64% lower than the value calculated from the batch. When sharp-grained dusty sand is used, the loss is greater, amounting to 1.13%. This loss is suggested as the reason for sharp-grained sand being easier to melt than round-grained, leaving less silica for fusion. These results are confirmed by the data from other analysts, showing that the percentage of silica found is usually smaller than that calculated for a given glass.

Influence of oxidizing and reducing agents on selenium glass colors. ALEXANDER SILVERMAN. *Jour. Amer. Ceram. Soc.*, **11** [2], 81 (1928).—The effects of oxidizing and reducing agents on the colors produced in selenium glasses are discussed.

Absorption experiments on glasses and filter substances by the method of radioactive indicators. HERTA LENG. *Akad. Wiss. Wien. Ber.*, **136**, 2a [1–2], 14–42 (1927); *Sci. Abs.*, **30,** 832 (1927).—Measurements were made of the adsorption of ThB, ThC, and Po and with lead salts on various materials and glass. Approximate agreement was generally obtained with the Freundlich equation: $a=\alpha c^{1/n}$. With different types of glass large variations are obtained in the constants of the above formula the value of $1/n$ ranging from 0.012 to 0.59. The adsorption on glass tends to saturation at values which for the different glasses are found to be parallel with the potentials measured by Horowitz with these types of glasses when employed as acid-alkali cells. Experiments with acids and alkali show that with positive charge of the boundary the amount of adsorbed material is diminished. The adsorption of Po is considerably less on hard Jena glass than on a soft glass. D.E.S.

Annealing of glass. E. O. HILLER. *Amer. Glass Rev.*, **47** [6], 17 (1927); *Nat. Glass Budget*, **43** [27], 3 (1927).—Although the complete annealing of glass is theoretically impossible yet practically, it is accomplished to a varying degree, as required for the intended service of the article. The difference in physical properties of glass and other common materials is discussed in relation to the effect of heat treatment. A picture of the annealing process is obtained from H.'s example of a glass sphere at 1000°F, relatively plastic and capable of deformation, being set out to cool freely. An outer layer or shell of chilled glass soon forms. Contraction is begun on the surface, but is halted by the incompressibility of the molten glass within and hence retains its original shape and size. The gradual cooling of the interior sets up high internal strains due to its tendency to contract, which is checked by the already set outside shell. Breaking is often the result. The same cooling conditions may be applied to the cooling of bottles after forming. In order to remove these strains set up due to forming, etc., it is necessary to heat up the article to a temperature at which the glass is plastic enough to

allow these strains to relieve themselves and maintain this temperature for a definite period. The cooling after annealing sets up a temperature difference between the outer surfaces and the interior and the magnitude of this temperature difference controls the possibility of restraining. The allowable rates of cooling have all been established by research and it is noted that at temperatures lower than 140–180°F below the higher annealing temperature used for relieving the initial strain, it was impossible to reintroduce strain regardless of the rapidity of cooling. As the annealing temperature for bottles is generally between 950–770°F, the critical period is above 770°F when the initial strain is introduced and after that temperature any strains that take place will not be permanent and will disappear completely when the ware comes to a uniform temperature throughout. Modern annealing apparatus will solve this problem. The higher the temperature at which relief of the intial strain is attempted, the quicker it can be accomplished, but at the same time the slower must be the cooling. If this temperature of relief is taken slower, then the cooling may be more rapid. A means of establishing the degree of strain was developed by the use of the polariscope with Nicol analyzer, equipped with a first order of red selenite plate and a high power lamp. A chart was made up in which the dead line between commercial and noncommercial ware is approximately grade "D." (A) all pink, commercially perfect; (B) red and blue only, highly commercial; (C) orange and blue-green, commercial; (D) orange, yellow, green, unsafe to use, (shows distinct black cross in bottom when observed through polariscope without color plate); (E) strains due to cords of intensity. Classes D and E subject to spontaneous breaking. This is a result of a very extensive study of thousands of bottles of 27 different types. Hence the polariscope is a valuable instrument, but because no strain is indicated does not mean that the ware is not sensitive to shock or that it will not break after packing, since a corded structure in glass or nonhomogeneous glass is found to do this. P.F.C.

Old window glass factories not known today. J. M. HAMMER. *Amer. Glass Rev.*, **47** [10], 27 (1927).—The passing years 1890–1927 bring marked changes in the window glass industry as to locations, decrease in number of plants, methods of production, and quality, which are unequalled in any other field. New Jersey was formerly the center of production. By 1905 hand processes were obsolete. The growth of machinery in the industry can be readily traced; the concentration of large melting units and the introduction of the crude cylinder machines were the first steps. At about 1890, the largest organization in the production of window glass was the United Glass Co. (19 factories in as many towns) which is unknown today. In the early 90's there were 3 territories producing window glass; namely, the northern, including New York and Massachusetts; the eastern, including New Jersey, Maryland, Delaware; and the western, covering west Pennsylvania and all other territory not already included. The important center today, West Virginia, was unheard of then. Cheap gas attributed the greatest factor in influencing the change in window glass history. Sheet drawing machines of late years have not exerted nearly the influence that cheap fuel did at that time. A list of former manufacturers and the prominent centers are given. P.F.C.

Raising glassware rates. ANON. *Amer. Glass Rev.*, **47** [11], 20 (1927).—A bill proposing, for a 3-year period, increased duties on imports of glassware and china into the Netherlands was introduced into the Dutch Parliament at The Hague. The increase would be 8 to 15% *ad valorem*. P.F.C.

Glass distributors act on trade problems. ANON. *Amer. Glass Rev.*, **47** [11], 25 (1927).—A committee was appointed to work with the glass manufacturers on the trade evils and voted to send a letter to the Tariff Commission in Washington asking that the present tariff situation as regarding flat glass be adjusted promptly and that the producers be given the relief which they seek. Trade conditions were discussed frankly

and views on the situation given by W. L. Monro, H. E. Allen, C. J. Gundlack, D. H. Startsman, S. C. Gilmore, W. J. Schoonover, L. N. Cobbledick, and R. B. Tucker. P.F.C.

Specifications for shipment of table ware. ANON. *Amer. Glass Rev.*, **47** [12], 16–17 (1927).—The freight container bureau of the American Railway Association recently issued a circular on recommendations as to the packing methods and constructional details of containers used in the shipment of glass table ware. The suggested specifications for slack barrels, used for the shipping of these wares, as well as those concerning the wrapping and inside packing of the goods, are based on an exhaustive survey made by the bureau for the purpose of affording the shippers better and more efficient service. Emphasis was placed on the necessity of using properly constructed barrels and also on the careful packing of the ware. The specifications regard slack barrels, hoops, size and strength of container, inside packing, and ranges in sizes of barrels used. P.F.C.

Glass sand shows proper iron content. ANON. *Amer. Glass Rev.*, **47** [14], 14 (1927).—Chemists interested in glass sand analysis are offered a standard sample showing iron content by Bureau of Standards. One of the essentials in the manufacture of glass is a supply of good glass sand, and one of the requirements of such a sand is a minimum iron content. Methods for the determination of such small amounts of iron have been tested in connection with the standardization of the Bureau of Standards standard analyzed sample of glass sand No. 81. Unsuspected sources of error in some of the methods have been found and the reliance that can be placed on the percentages of iron obtained has been established. The standard sample is being distributed at cost, which amounts to $2 for 60 grams. P.F.C.

The annealing of glass. H. V. E. RENN. *Glass*, **4** [10], 428–35 (1927).—Annealing is the term used to characterize the process of controlled cooling intended to diminish or prevent the occurrence of internal stresses set up when glass is rapidly cooled. When glass in a plastic state is allowed to cool rapidly in air, internal stresses are set up. Two kinds of strains are involved, the temporary and permanent strains. Temporary strains are those set up on cooling which are opposite in sign to those established on heating and exist as long as a temperature gradient is maintained. The distribution of stress on heating and cooling explains the well-known fact that glass will withstand much more rapid heating than cooling, the strength of glass being much greater when under compression than when under tension. Composition however also tends to modify this degree of difference. Permanent stresses are obtained by rapidly cooling glass from the temperature of mobility to room temperature, when it acquires stress equal in sign to the temporary stress produced by heating and these stresses are acquired at low temperatures. The permanent strain acquired by a piece of glass when cooled is equal and opposite in sign to the temporary stress lost by viscous yielding in the early stages of the cooling process. Thus a piece of glass cooled in this way may appear well annealed at its original temperature gradient, but strain will appear as temperature uniformity is established. Therefore to obtain well annealed glass, it is necessary to cool the glass very slowly from temperatures at which it is just mobile in order that the temporary strain just set up will be small and the amount of strain lost by the viscous yielding will be also correspondingly small. The main factors governing any process of annealing are: (1) the temperature at which strain takes a definite time to disappear, invariably referred to as the annealing temperature; (2) the temperature below which only temporary strain is acquired by the glass, often referred to as the lower critical temperature; (3) the rate of change of mobility or flow which governs the manner of cooling between the annealing and the lower critical temperatures. The universally adopted definition of annealing temperature is that temperature at which 95% of the initial stress present in the glass can be relieved in 3 minutes.

This temperature however will vary with the type of glass and often with glasses of the same type but with different proportions of the same constituents. A careful determination of the annealing temperature is therefore essential if the best of annealing is to be desired. The methods employed for this determination are: (*a*) the optical method; (*b*) location of the zone of abnormal heat absorption; (*c*) variation of thermal expansion at high temperatures; and (*d*) mechanical methods. Summarized, the above methods are as follows: (*a*) In the optical method, a prepared sample of the glass is placed in a tube furnace and the effect of slowly raising the temperature on the degree of strain observed by means of Nicol prisms placed at either side of the furnace. The Nicols are so arranged that the light directed onto the one will become polarized while the Nicol constituting the eye piece is set in the cross position. The field of view is thus uniformly dark, but a sample of glass containing strain placed in the path of light will show bright areas. If the glass is now heated at a constant rate, the intensity of the restored light will also remain constant until those temperatures are reached at which the glass begins to flow. Here a perceptive decrease in the intensity of light will occur, indicating the release of stress set up by the temperature gradient. Data can thus be obtained showing the rate at which stress is relieved at different temperatures. (*b*) The location of the zone of abnormal heat absorption can be found by the use of the differential thermocouple method or by the employment of a single couple. The latter involves the measurement of the time required by a sample of glass to rise through successive short and equal steps in temperature. From experiments it has been found that in the softening range, glass shows an increased absorption of heat on heating, while on cooling there is evidence of a decrease in the evolution of heat in passing through the same region. Hence it is possible to determine the annealing range. It is thought advisable to carry out the process of annealing below the temperature where the glass becomes too soft; it appears that the region of this heat absorption must be considered as defining the upper limit of the annealing range. (*c*) Variation of thermal expansion at high temperatures is best obtained perhaps by use of the Fizeau-Pulfrich interferometer, which is extremely sensitive and is especially adaptable to the use of small specimens, its small size simplifying the problems of uniformity of heating and temperature control. It is found that glass passes through a critical expansion period in which the rate of expansion increases from 2 to 7 times. This region does not exceed 40°C for any one glass and was found to be identical with the region of abnormal heat absorption. (*d*) Mechanical methods seem to have proved the most popular and one of the best is here given. It is the apparatus designed by Twyman and consists of an electric furnace, a pyrometer and temperature indicator, an illuminating lamp, a telescope, and a jig for holding the strip of glass under test. The electric furnace is of the tube type pattern wound with nichrome wire, and is fitted with mica windows. A switchboard, ammeter, and regulating resistance are supplied. The pyrometer and indicator consist of a Pt:Pt-Rh thermocouple and millivoltmeter reading direct in degrees centigrade. The jig is of nickel or of nichrome and is so constructed that one end consists of a socket into which the small glass strip may be slid and the other end is fixed to a weighted arm. The inclination of the arm therefore measures the bending of the strip and this inclination is observed and measured by the telescope, which has a graticule in the eye piece, capable of being turned into any position of orientation, its rotation being measured on a divided circle. The fall of the weighted arm is expressed in degrees per hour and curves are provided whereby the annealing temperature can be immediately determined from this one reading. Twyman's mathematical formula, which determines the best rate of cooling, is also obtainable in order to secure the best degree of annealing in a given time. The importance of knowing the annealing temperature of a glass and the time for which this temperature should be maintained in order to relieve a given amount

of strain cannot be over-emphasized. If an attempt be made to anneal glass above its annealing temperature it will acquire permanent stress when temperature uniformity is established at ordinary temperatures. On the other hand, if the temperature is too low, it will not be annealed at all. The time in which stress can be relieved varies enormously with the temperature. P.F.C.

New uses for plate glass. ANON. *Nat. Glass Budget*, **43** [27], 7 (1927).—Lack of new ways for the utilization of plate glass has been advanced as a serious trouble. It is not because it cannot be substituted for other building materials and other numerous purposes but because it has not been given the suitable amount of consideration. A press dispatch from Berlin states that nearly an entire school is to be constructed of glass, steel and concrete being used for the framework only. The outside walls and partitions are to be of plate glass. If this experiment proves satisfactory, this method will be employed in the city entirely in the future. P.F.C.

Value of "Scatter-Proof" glass. ANON. *Nat. Glass Budget*, **43** [28], 3 (1927).—The value of this glass manufactured by the Indestructo Glass Corp., of Farmingdale, L. I., N. Y., is thought proven by the results seen in the accident of one of the planes at Curtiss Field. The lights of glass in the plane withstood the test remarkably well. Airplane corporations using this glass are noted. P.F.C.

Belgian window glass situation changing. ANON. *Nat. Glass Budget*, **43** [29], 14 (1927).—The Belgian window glass industry is in the midst of a great change from the hand-operated system to the machine-made process, accompanied by seemingly unsolvable problems. The lowest permissible price for window glass is reported. The machine-equipped plants are working on a very narrow margin and many are on the verge of closing, while the hand-operated plants are having a struggle to keep pace with the more modern plants. The increased production and the low prices are forcing manufacturers to get together for self-protection. This is stated as the saving of many of the concerns. Difficulty is claimed for the marketing in foreign lands for 95% of the window glass made in that country. For article on same subject see *Nat. Glass Budget*, **43** [28], 5 (1927). P.F.C.

Fire extinguishers in glass containers. ANON. *Nat. Glass Budget*, **43** [30], 3 (1927).—A new use for glass which probably will interest every glass manufacturer and jobber is the new glass containers for chemical fire extinguishers. There are two shapes required, one similar to a pear and the other a cylinder. When the glass is broken and the liquid released a gas is generated of 500 times the volume of the liquid, which smothers the fire. This gas is noninjurious to the finest of fabrics or to human beings and by being so put up, eliminates the troubles incurred by the use of metal containers which are more expensive, contain complicated workings, and are liable to jam and corrode. P.F.C.

Standardizing the height of all beverage bottles in the near future. ANON. *Nat. Glass Budget*, **43** [30], 3 (1927).—Real constructive work was carried out at the convention of the American Bottlers of Carbonated Beverages. One of the main subjects was the attempt to standardize all equipment used by the bottlers and to see that all supplies and equipment are sold to all bottlers on the same basis. This standardization of bottle heights and diameters in relation to their volumetric content would be a great help to the manufacturers in that they could obtain stock castings, etc. Other subjects of interest are the development of better bottles to withstand temperature changes and investigations as to the solubility of glass in various alkali solutions. P.F.C.

New type of windshield for Ford cars. ANON. *Nat. Glass Budget*, **43** [31], 6 (1927). —The new model Fords are reported as equipped with windshields of laminated glass, that is, 2 sheets of single strength window glass with a substance placed between and

subjected to a treatment that gives it a greater resistance to shock and less danger of breaking due to accidents. This is the first time window glass has been used in the manufacture of laminated glass. P.F.C.

Conditions in plate glass industry. SCHOONOVER. *Nat. Glass Budget*, **43** [32], 3(1927).—S. discusses the chaotic condition in the plate glass industry. Overproduction is blamed for the present state of affairs and this in turn may be attributed to the competitive basis due to different machine methods. The natural course taken when overstocked was to slash prices. The distributor in many ways is receiving the brunt of this and unless conditions are bettered, the future is serious. Although foreign competition is serious, it is believed that an equilibrium can be attained between the domestic and alien product by requiring the business man be a student of economics. Competition by law must be unrestrained. Two remedies for the present situation are (1) increased prices and (2) the elimination of waste. Examples are given of elimination of unnecessary stock and of the many varied wastes which have solved such problems in other industries. It is suggested that consolidation might be the salvation of the glass industry from its present state of affairs. P.F.C.

The plate glass industry. TUCKER. *Nat. Glass Budget*, **43** [32], 6(1927).—The important features of the plate glass industry are discussed as they exist today. The keynote of today's problem seems to be that production is exceeding demand, which naturally will bring about a crisis in time in the financial affairs of a company. To solve this problem, the plate glass industry chose the uneconomic method of cutting prices, rather than adopting the modern and scientific method of adjusting production to meet demand. If balance is regained, it is suggested that in order to prevent a recurrence of this state of affairs a movement within the industry be started to balance production and demand in order to stabilize prices, wages, and employment. It is pointed out that though the manufacture and the distribution of glass are two distinct and separate industries, the interests and problems are so closely allied that a disastrous policy for one is almost equally disastrous for the other. The price cutting scheme has undoubtedly caused heavy suffering in inventory values to the glass distributor and has gained nothing for the manufacturer, but instead has created a lower level of values with the same problems of supply and demand. Undoubtedly the foreign manufacturers in their policy of marketing a considerable ratio of their shipments to this country in channels that undermine the very foundations of the distributor's business are instrumental in this crisis to some extent. P.F.C.

A good tank record. ANON. *Nat. Glass Budget*, **43** [33], 18(1927).—The 19-ton generative day tank in the Radiant Glass Co. has produced glass steadily for 57 weeks with a loss of only 4 hours, during which time blocks were set. The glass runs the same every day. It is filled in at 2 P.M. and is ready at 6 o'clock the next morning. P.F.C.

German glass information. ANON. *Nat. Glass Budget*, **43** [34], 6(1927).—The number of glass workers fully employed has increased considerably since the first of the year. The movement toward concentrations into syndicates and mechanical improvements characterized the German glass industry during 1926. Modernization of plate glass producing installations is progressing, although the small plate glass producers cling to the antiquated methods of production. Bottle plants are considerably more modernized. A new plant was just opened for the production of bulbs for electric lights. P.F.C.

Why expensive perfumes demand crystal containers. ANON. *Nat. Glass Budget*, **43** [34], 10(1927).—Perfumes, unlike flowers from which they come, cannot thrive in ordinary surroundings, says Lucien LeLong, the famous Paris *couturièr*. They require the delicate protection of fine glass houses. As soon as a precious essence touches the cheap glass bottle of coarse and relatively porous walls, it sickens and fades. Gradually

the properties which made its fragrance tantalizing to the sense disappear, and in a matter of a few weeks the perfume is as ineffective as colored water. Valuable flasks on the other hand cause the perfumes to improve with age. This explains why the best perfume bottles are made from uncut crystal, the costly basic material for cut glass. The stopper also should be chosen with the same care without view of economy. Regardless of the ornament adorning the stopper, the portion coming into contact with the liquid should be of solid crystal foundation. P.F.C.

New uses for glass. ANON. *Nat. Glass Budget*, **43** [35], 3 (1927).—The position of Libbey-Owens in the window glass industry is discussed. Conditions encountered during the past year and prospects for the present one are given. New uses for glass and possible new method of manufacture of flat drawn window glass, the non-shatterable glass, and the ultra-violet ray glass are discussed. P.F.C.

Obstacles in the glass industry in 1927. ANON. *Nat. Glass Budget*, **43** [35], 3 (1927).—A review of the past year is made in which it is found that especially the plate, window, rough rolled, tableware, and scientific glassware manufacturers did not benefit so much. Low prices, active participation in an attempt to take business away from a competitor, imports of table ware from Germany and flat glass from Belgium and Czechoslovakia, syndicate buying, and hand to mouth ordering may be included as the leading contributing factors that have caused the glass industry in general to be in such an unsatisfactory condition. The question of who is to carry the stock of finished merchandise, the manufacturer or the distributor is discussed. F.P.C.

Two-year comparison of plate and window glass imports. ANON. *Nat. Glass Budget*, **43** [35], 3 (1927).—Imports of these two products of flat glass are summarized for the first 10 months of 1927 or as far as the foreign commerce reports have been issued. P.F.C.

Glass conditions in China. ANON. *Nat. Glass Budget*, **43** [34], 19 (1927).—There are at present about 60 glass and porcelain works of any importance in China, most of them making glass articles, such as lamps, lamp chimneys, bottles, cups, and bowls. The best glass sand comes from Japan and is especially adaptable to the making of glass bulbs. Glass chimneys and bottles are used extensively throughout China. Wages are extremely low. Owing to the crude methods employed and lack of modern machinery, hardly any expensive plate and window glass or high-class glass and china ware for every day use is made in China. P.F.C.

Nero first to wear glasses. ANON. *Nat. Glass Budget*, **43** [35], 11 (1927).—Opticians claim that Nero was the first to wear spectacles and that they were of emerald and worn as a protection from the bright rays of the sun more than an aid to the eyes. It is said that spectacles were worn in the early days of the Chinese mandarins. These were of plain glass and worn to give the appearance of wisdom and dignity. In the time of Charles I in England the first spectacle making company came into existence and dealt in spherical lenses and rims. These were used as magnifying glasses and advertized as "a blessing to the aged." About 100 years ago an Ipswich optician by the name of Fuller invented cylindrical glasses which helped persons suffering from astigmatism. P.F.C.

Electrical conductivity of glasses. M. FULDA. *Sprechsaal*, **60** [42], 769–72; [43], 789–91; [44], 810–13; [45], 831–33; [46], 653–55 (1927).—A review of the work of previous investigators is outlined. The work of F. is summarized as follows: (1) Various methods are described for measuring the electrical resistance of glasses from room temperature to 1200°C. (2) The resistance of a Thuringer glass is measured from 25 to 1200°C by which is proved the validity of the law of Rasch and Hinrichsen that: Log $w = A/T + B$. (3) The crystallization and the melting of crystals manifested itself in marked anomalies of temperature-resistance curves. These anomalies can be reversed for the detection

of metamorphoses. (4) The temperature of strain variation indications due to the coefficients *A* and *B* in the law of Rasch and Hinrichsen was established by numerous systematic trial melts and so the influence of the individual glass components on the annealing temperature determined. The effect of the various components of glass influence the annealing temperature in the following sequence: CaO, B_2O_3, Al_2O_3, MgO, ZnO, and SiO_2 raise the annealing temperature while BaO, Fe_2O_3, PbO, K_2O, and Na_2O lower it. (5) The electrical resistance was measured on the same trial melts and the influence of the individual oxides on the resistance of the glasses determined. The individual components of the glasses arrange themselves according to their influence on the insulation capacity of the glasses as follows: CaO, BaO, B_2O_3, PbO, Fe_2O_3, MgO, ZnO, and SiO_2 increase resistivity of the glasses, and Al_2O_3, K_2O, and Na_2O reduce it. (6) The strength of the precipitated amnion on this series of melts due to steam saturated air was determined by their electrical conductivity. As the percentage of alkalis increases, the resistance to piercing is increased; with the remaining components a minimum is obtained by a determined per cent of content. Relative to the influence on the hindrance of the formation of an amnion the components of glasses were arranged in the following sequence: CaO, B_2O_3, BaO, Al_2O_3, Fe_2O_3, MgO, ZnO, PbO, SiO_2 hinder the formation of the amnion, while K_2O and Na_2O promote such formation. (7) From the results of the measurements of the resistivity of the glasses with and without amnions several conclusions of practical value were obtained. It is possible to state the composition of good glasses which in extent of pure resistance without an amnion exceed both quartz and porcelain. Good glass insulators can be made which have insulation capacity exceeding that of porcelain insulators. R.A.H.

Solution of glasses in water. PAUL TIETZE. *Sprechsaal*, **60** [44], 813–14 (1927).—Several graphs and a table of various composition glasses are given to illustrate rates of solution of these glasses due to composition. R.A.H.

Regenerators. M. J. BRADLEY. *Ceram. Ind.*, **10** [1], 50–52 (1928).—A brief review of the history of the St. Gobain plate glass works and of the regenerator principle applied there. F.P.H.

Glass plant wins a foreign market. FAYE BENNISON. *Ceram. Ind.*, **10** [1], 57–58 (1928). F.P.H.

Fine annealing of optical glass. ANON. *Ceram. Ind.*, **10** [1], 58 (1928).—It has been shown by investigators both in the U. S. and abroad that the index of refraction (and other physical properties of glass) are affected by the time and temperature at which the glass is annealed. In preparing some glass for precision optical instruments it was found that the glass which was presumably well annealed showed variations from the average index of the magnitude of 37×10^6. This variation was somewhat greater than was desired, and the glass was reannealed at a temperature of 486°C for 14 days. Experiments and results obtained are described. F.P.H.

Electric furnace in glass manufacture. ANON. *Ceram. Ind.*, **10** [1], 58 (1928).—A stained glass manufacturer in England has installed what is believed the first electric furnace of its kind. This furnace has top and bottom nickel-chrome heating elements totally enclosed in special brick. The glass is treated in trays at various temperatures between 300 and 950°C which are obtained by a specially designed rheostat in the heating circuit. Auxiliary chambers at the top and on both sides of the kiln are used as preliminary warming compartments. The electrical furnace saves almost half the operation cost and the quality of the product is of a much higher standard, it is said. F.P.H.

Glass factory in the days of Nebuchadnezzar. A. E. MARSHALL. *Bull. Amer. Ceram. Soc.*, **7** [1], 5–9 (1928).—See *Ceram. Abs.*, **6** [5], 170 (1927). E.J.V.

Modification in tank design and construction. I. O. PEDERSON. *Glass Ind.*, **9** [1], 1–4 (1928).—The present conventional designs of tanks are believed to be such as to

cause a misuse of fuel due to the heat lost from the hot gases in the excessive free open volume above the glass in the melting end. A low crown is to be preferred to a high crown as has been proved in the steel industry. The conditions existing in the conventional design of melting tank are discussed in detail and a heat-balance on such a tank is given, showing the large unaccounted-for losses. The general data used in making the heat-balance is given. A new type of melting tank has been conceived and particular features are enumerated. These include features at the melting end peculiar to an open-hearth steel furnace, two dog houses, one at each end of the tank; the usual breast walls are absent, so both the neck and refining chamber are provided with low crowns. An approximate heat-balance for the new tank is given. The various points taken into consideration are discussed in detail, and others mentioned. E.J.V.

Laminated glass situation. ANON. *Glass Ind.*, 9 [1], 6 (1928).—A discussion of the production of laminated, non-shatterable glass for automobile windows and windshields. The most serious problem in the making of this kind of glass is to keep the three laminations, which go to make up non-shatterable glass, from separating. The glass must stand the test of time without the layers of glass separating or the plastic center clouding over and becoming opaque. The essential although seemingly insignificant basis of success is cleanliness and attention to detail. The whole process is extremely delicate. The various steps are briefly discussed. There are 17 different processes involved. E.J.V.

Meeting of the German Society of Glass Technology. ANON. *Glass Ind.*, 9 [1], 7–11 (1928).—A brief account of the meeting held at Berlin, November 10 and 11, 1927. A feature of the meeting was the exhibition of synthetic raw materials for the glass industry. Gehlhoff gave a lecture on the new glass bulb works of Osram, Siemensstadt, Berlin. Brief abstracts of the following papers are given: "Stress Phenomena in Glass," by F. Rinne; "Electric Heating of Glass Cooling Ovens," by K. Tamele; "X-ray Methods of Investigation," by S. Gottfried. E.J.V.

Composition of modern glass mixtures. OSKAR LECHER. *Glass Ind.*, 9 [1], 10–12 (1928); reprinted from *Continental Met. Chem. Eng.*—For the production of beautiful shining red colors, the so-called "ruby glasses," gold ruby, selenium ruby, and copper ruby are used. Gold ruby may be made in tints ranging from delicate pink to deep purple, according to the amount of gold present. Deep, rich, blood-red shades are produced by the addition of copper, while selenium produces a shining cinnabar color. The manufacture of ruby glasses is comparatively difficult. The general success of the process as well as the intensity and shade of the coloration is largely dependent upon the care applied to the production of the gold chloride. The method of producing gold chloride from pure gold is described in detail. A very heavy Bohemian lead crystal is made of the following mixture: 100 Hohenbocka sand, 191 minium, 8 potash (98%), 12 potassium nitrate, 0.7 antimony, and 25 pure gold and 10 pure tin dissolved in acid. This corresponds to a composition of 34.71% SiO_2, 61.46% PbO, 3.82% K_2O, and 9.01% Au. Other very good mixtures are:

	I*	II	III	IV
Sand	100	100	100	100
Minium	80	125	82	16
Potash	11	25	25	20
Potassium nitrate	12	16	10	10
Borax	14			32
Tin (dissolved	0.80		1	0.50
Pure gold in acid)	0.02	0.08	0.025	0.06
Antimony oxide	0.80			
Arsenic				1
Potassium tartrate		1		0.90
Antimony			2	

* Corresponds to a composition of 41.53% SiO_2, 48.30% PbO, 10.17% K_2O, and 0.03% Au.

Two lead-free mixtures are:

	I	II
Sand	100	100
Borax	19	
Potassium nitrate	1	1
Potash	32	27
Potassium tartrate	0.60	1
Pure gold dissolved	0.07	0.06
Pure tin in acid	0.10	1
Arsenic		0.5
Lime		13
Soda		6

A mixture very rich in gold and lead, and very deep in color, which is much used for flashing coat and also for coloring opal glasses, as well as for the production of marbled glasses, is: 100 sand, 120 minium, 30 potash, 8 potassium nitrate, 4 borax, 0.10 pure gold and 2 pure tin dissolved in acid, and 1.2 potassium tartrate. Melting temperatures are comparatively high and should be maintained as long as possible to assure perfect mixing of the gold with the glass flux. Characteristic properties of gold ruby glasses are discussed. In the production of copper ruby glasses, the glass mixtures used must not be too hard, the amount of copper used should be limited, and a slightly reducing furnace atmosphere should be maintained throughout. Melting must be effected at high temperatures, which should be kept up for a comparatively long time in order to assure uniform absorption of cuprous oxide by the glass. Several mixtures are given, as follows: (I) hard glass, (II) soft glass free from lead, suitable for flashing glasses, (III) similar composition, (IV) garnet red, (V) rich in lead and particularly suited for flashed glasses.

	I	II	III	IV	V
Sand	100	100	100	100	100
Lime	12	30	15	14	
Potash	31			20	25
Soda	2.7	35	33	12	
Borax	0.5	9	3	8	15
Cuprous oxide	150	4	1.5	0.3	2.5
Sodium sulphite	200				
Sodium tartrate	400	2	0.5	0.45	
Stannic oxide		4			5
Potassium nitrate		4		3	4
Iron oxide		1			0.2
Tin ashes			2	0.15	
Selenium				0.14	
Minium					25
Manganese dioxide					2.5

Analyses are as follows:

	I (%)	II (%)	V (%)
SiO_2	77.21	65.22	62.31
Al_2O_3	0.62	0.64	0.84
Fe_2O_3	0.05	0.66	0.16
CaO	5.20	11.05	0.12
MgO	0.03	0.04	0.01
Na_2O	1.24	13.50	1.54
K_2O	15.44	1.31	11.23
CuO	0.12	2.62	1.40
B_2O_3	0.24	2.37	3.09
SnO_2		2.60	
PbO			14.94
MnO			1.25

The method used in Bohemian glass works to produce copper ruby flashed glass is given.

E.J.V.

Analysis of light-diffusing glasses. J. B. KRAK. *Glass Ind.*, **9** [1], 12–13 (1928).—Some batches for the production of light-diffusing glasses are listed to show the variety of ingredients which may be used. A complete qualitative chemical analysis is of urgent need in this connection. An outline for analysis is given to determine quantitatively: silica and fluorine, by Berzelius' method; sodium and potassium oxides by J. Lawrence Smith method; and methods for determination of lead, aluminum, iron, titanium, calcium, magnesium, and zinc. E.J.V.

Some achievements of Hazel-Atlas. G. WESLEY EVANS. *Glass Ind.*, **9** [1], 16 (1928); reprinted from Grafton (W. Va.) *Sentinel.*—A historical account of the founding of the Hazel-Atlas Glass Co. in 1886, and its growth to the present day. The plants operated by this Company are listed and the types of products are discussed. E.J.V.

Breaking tank glass by compressed air. ANON. *Glass Ind.*, **9** [1], 21 (1928); reprinted from *Compressed Air Magazine.* See also *Ceram. Abs.*, **6** [6], 215 (1927). E.J.V.

Strain in glass bulbs. SANGORO TAKAHASHI. *Jour. Jap. Ceram. Assn.*, **33** [390], 236–40 (1925).—Strain in unannealed glass bulb is observable especially at its head and neck, since they touch the mold for a longer time than the other parts. In this respect, a wooden mold is better than metal one, especially when its paste is worn out. The strain in bulbs made of a lead-soda glass was released at temperatures higher than 475°C while they were deformed at 550° or higher. 500°–600° are most suitable for their annealing. S.K.

Study of soda-borosilicate glasses. I. KITSUZO FUWA, FUJIO SUZUKI, AND MASABUMI SATO. *Jour. Jap. Ceram. Assn.*, **33** [394], 414–55 (1925).—Working nature, thermal properties, and durability of borosilicate glasses $0.25–2.0Na_2O \cdot 0.1–6.0B_2O_3 \cdot 6SiO_2$ have been studied. An oil-fired pot furnace in which a temperature of 1400°C was easily attained has been used. (*1*) *Experiment on melting.* Conclusion: In the glasses $yNa_2O \cdot xB_2O_3 \cdot 6SiO_2$ only those satisfying the relation $4y > x > {}^1/_4y$ are satisfactory in respects of melting and working. (*2*) *Analysis of the glasses.* In general a considerable loss in boron has occurred in the process of melting. Pots were corroded by the glasses rich in boric acid and soda. (*3*) *Changes on reheating.* Disks made of the glasses were reheated for 1 hr. at 750°C with the result that those very rich in boric acid were apt to be opacified, whereas those poor in the acid had a tendency of sustaining surface devitrification. **II.** *Ibid.*, **33** [396], 561–73 (1925).—(*4*) *Thermal expansion.* Thermal expansion of the glasses varies chiefly with proportion of soda, the influence of boric acid being very slight. Compared with that of Pt it amounts to from 30 to to 100% or more. (*5*) *Softening temperature.* (*a*) Expt. with glasses $Na_2O \cdot 0.2–4.0B_2O_3 \cdot 6SiO_2$. The softening temperature was highest at $0.8–1.0B_2O_3$ and lowest at $3.0B_2O_3$. (*b*) Expt. with glasses $0.25–2.0Na_2O \cdot B_2O_3 \cdot 6SiO_2$. The temperature descended with increase of soda. (*6*) *Pull test.* When one of the contents in soda and boric acid is constant, the elongation increases with the increase in the other. The increase in elongation is reduced with increase in the content of the fixed oxide. (*7*) *Thermal resistivity.* Generally speaking this kind of glass withstands well sudden changes in temperature. The resistivity is markedly reduced by increasing the alkali over $1.0Na_2O$, while the glass with a smaller alkali content shows a good resistance regardless of the content in boric acid. **III.** *Ibid.*, **34** [398], 67–77 (1926).—(*8*) *Durability.* The borosilicate glasses $yNa_2O \cdot xB_2O_3 \cdot 6SiO_2$ resist better to water and hydrochloric acid than to solutions of caustic soda and sodium carbonate. Chemical composition has marked effect on the resistance. The influence of boric acid compared with that of soda is very remarkable. The resistance is strong when x is about 0.75 and is distinctly reduced when it is increased over 1.0. S.K.

Glass industry in Japan. KIYOSHI NAKAO. *Jour. Jap. Ceram. Assn.*, **33** [394], 456–85 (1925).—A short history of glass industry in Japan and a complete description of its present state is given with many statistical tables and lists of important manufacturers. S.K.

Study on the ray-transmission of glass. Glasses opaque to visible rays and transparent to ultra-violet rays. JUSEI SUGIE. *Jour. Jap. Ceram. Assn.*, **34** [397], 24–33 (1926).—Transmissibility of visible and ultra-violet rays has been investigated on various glasses containing Ni or Ni and Cu. Conclusions are: (a) Nickel glasses are in general transparent to ultra-violet rays regardless of their chemical compositions excluding Ni. The minimum wave-lengths with sheets which are about 1.5 mm. thick and made of glasses containing 8–10% of Ni are 290–300 $\mu\mu$. (*b*) The transmission of ultra-violet rays is little affected by the difference in the kind of alkalis, whereas that of visible rays is influenced by it in such a way that the maximum wave-length is generally longer in potash glasses than in soda. (*c*) The transmission of visible and ultra-violet rays of Ni glasses decreases with increase in Ni content. It is also reduced by increasing their thickness. Addition of nickel oxide over 10% to a glass makes it brittle and the oxide remains sometimes undissolved in it. (*d*) As to the reduction of the transmissibility of red light by introducing Cu to Ni glass it may be said that a small addition of CuO (about 1%) is not injurious for certain uses, although the oxide has a strong tendency to reducing its transparency toward ultra-violet rays. (*e*) Co acts like Ni. So Co may be used in place of Ni in the preparation of black glasses transparent to ultra-violet rays. The presence of Ni and Co together injures the transmissibility to ultra-violet rays. S.K.

Discoloration and devitrification of glass in blow-pipe working. SANGORO TAKAHASHI. *Jour. Jap. Ceram. Assn.*, **34** [399], 120–24 (1926).—Tubes made of various glasses have been worked in reducing and oxidizing flames of a coal gas. The results are: (*a*) Generally speaking, lead and zinc glasses are liable to be blackened by reducing flame, while lime, boric acid, baryta, and magnesia glasses have tendencies to be devitrified. The discoloration and devitrification are encouraged by increase in content of constituent other than silica and alkalis, while they are weakened by its decrease and increase in alkalis. (*b*) The use of oxygen instead of compressed air favors the devitrification. (*c*) Discoloration and devitrification cause a marked reduction in adherence of glasses. S.K.

Transmission spectrum of sheet glass. KITSUZO FUWA AND TETSUO HIRAOKA. *Jour. Jap. Ceram. Assn.*, **34** [407], 504–507 (1926).—Transmission spectra of 7 window glasses, of which one was frosted and another was ground, and 5 figured rolled plate glasses are compared with a spectrum of iron arc. Their thickness ranged from 1.30 to 6.75 mm. Chemical analysis are: silica 63.3–71.0, alumina 0.1–4.6, ferric oxide 0.090–0.205, lime 12.7–15.9, and alkalis 12.7–16.0. Results: (*a*) The minimum wavelength of rays transmitting these glasses was 3021Å. (*b*) The transparency of the glass to the spectrum is markedly influenced by the content of ferric oxide, *e.g.*, the minimum wave lengths of a plate glass containing 0.090% of ferric oxide and 4.30 mm. thick, and a window glass containing 0.103% of the oxide and 2.78 mm. thick are 3021 and 3065Å respectively. (*c*) The transmission of a glass is reduced by grinding its surface. The transmission of a ground glass remains unchanged whether the light source is placed toward the ground or unground surface. S.K.

I-type mixer for glass batches. KURASHIRO ISHIKAWA. *Jour. Jap. Ceram. Assn.*, **35** [411], 101–106 (1927).—The I-type mixer invented by I. has 4 rectangular compartments rotating around its axis. One of the compartments serves as a batch car which is joined to and detached from the mixer before and after mixing respectively. Since the mixer has no charging or discharging door, there is no need of inclosing. It is

less expensive and more efficient than the Smidth's, cube-and-drum mixers widely used in this country. S.K.

Transparency of sheet glass and paper. KIYOSHI UEDA. *Jour. Jap. Ceram. Assn.*, **35** [412], 165–67 (1927).—Transparency of sheet glass and paper has been studied with results as follows:

Sample	Thickness in mm.	Transparency in per cent
Window glass	1.70	93.7
" "	3.12	90.8
Polished plate glass	5.80	89.2
Mat glass (water ground)	1.51	82.7
" " (sand blasted)	1.75	74.4
" " (etched with ammonium fluoride)	1.90	85.8
Frosted glass	1.80	85.8
Figured rolled glass	3.00–4.50	96.2–71.8
Wire glass	7.00	89.2
Paper for paper slide door	0.08–0.13	30.2–37.2

S.K.

Protecting glasses. KITSUZO FUWA. *Jour. Jap. Ceram. Assn.*, **35** [415], 321–30 (1927).—(1) Chemical composition. Some of the protecting glasses on market were analyzed (Table I).

TABLE I
Chemical Composition of Some Protecting Glasses

	Amber B	Blue A	Blue B	Blue C	Fieuzel A	Crooks B
SiO_2	72.09	72.46	70.87	72.09	69.84	72.11
Sb_2O_3	—	0.84	1.11	0.99	0.84	2.90
$Al_2O_3+Fe_2O_3$	0.52	0.30	0.30	0.30	0.81	2.35
MnO_2	—	0.18	0.12	0.38	0.88	—
CoO	—	Trace	Trace	Trace	—	—
CaO	10.71	11.83	11.93	10.74	11.58	5.42
CeO_2	—	—	—	—	0.51	2.18
Na_2O	15.63	14.01	15.09	15.50	15.29	15.03
K_2O	Trace	Trace	Trace	Trace	Trace	Trace

Those prepared for the succeeding tests were soda-lime, soda-zinc, and borosilicate glasses containing one or more of 1.0–11.2% ceria, 0.2–5.0% uranium oxide, 1.32–3.0% iron oxide, and 0.04–0.1% chromium oxide as absorbents of ultra-violet rays. Small amounts of colorant such as NiO, MnO_2, or CoO have been added to their batches. (2) Color value and color of the glasses: Color values measured with Ive's tint photometer and colors are shown. (3) Transmission curve of visible rays: Curves obtained with Hilger spectrometer and Nutting spectrophotometer are shown. (4) Transmission: Transmission of the glasses are compared. (5) Spectrophotographs: Transmission spectra of glasses are compared with spectrophotograph of copper arc light. If Von Eugen Truempy's opinion is correct that ultra-violet rays with wave lengths ranging from 3140 to 3960Å are harmless to healthy eyes the glasses now on the market, except 3 blue ones, and those prepared in the study, are all fit for the purpose. Some of the excellent glasses are shown in Table II compared with the imported ones.

TABLE II
Ultra-violet End of Some Excellent Glasses

Glass	Color	Thickness in mm.	Ultra-violet end λ in Å
Crooks B	Light gray	1.5	3520
Soda-lead glass (4% ceria)	Slight gray	1.7	3520
" " " (5% ceria)	" "	1.9	3570
Fieuzel A	Slight green	1.4	3380
Soda-zinc glass (9% ceria)	Slight blue	1.8	3540
Borosilicate glass (5% ")	Colorless	1.9	3450
Amber	Orange brown	1.5	3250
Soda-lead glass (3% ceria+ 1.5% U_3O_8+1.05% Cr_2O_3)	Greenish canary yellow	1.7	3600

(6) Conclusions: (*a*) Glasses containing oxide of Ce, U, Fe, or Cr absorb ultra-violet rays well. (*b*) Almost colorless protecting glasses can be obtained by adding a suitable amount of ceria to the batch. (*c*) The dark green but inexpensive glasses can be manufactured with use of ferric oxides. S.K.

Study of glass stones. KIYOSHI UEDA. Asahi Glass Co., Ltd., *Research Rept.*, No. 14, pp. 1–12 (1925).—Defective glasses have (*a*) seeds or bubbles of gases, (*b*) cords or striae of a different glass, or (*c*) stones. (*1*) *Devitrification stones.* A photograph of stones consisting of minute cristobalite is shown. Sometimes they consist of tridymite, wollastonite, diopside, or Ca-Na-silicates. (*2*) *Batch stones.* U. found stones from sand which were quartz grains with minute crystals of cristobalite on their surfaces or cristobalite grains with crystals of tridymite along cracks in them. Every stone was filled with minute cracks. (*3*) *Crown drops.* An end of a crown brick exposed to the highest temperature in a tank furnace was filled with large crystals of tridymite and was covered with a thin film of glass having a few crystals of cristobalite. It is doubtful, however, whether stones are caused by the drops or not. (*4*) *Tank stones.* Sillimanite and corundum stones coming from tanks and floaters are the most common ones. Descriptions on flux blocks which had been used in a window glass tank are given. A thin layer of brown glass containing well developed crystals of corundum and sillimanite covers a white layer filled with well developed sillimanite on the inner side of the first course block just above the metal line; photographs of the brown glass indicate that it probably ran down to the metal; sillimanite crystals at the inner surfaces of the second and third course blocks are not developed since the surfaces had been corroded by the metal; therefore we can distinguish stones originating from these two sources. Another corundum stone consisting of clay and minute corundum crystals produced by the action of heat on diaspore or gibbsite in it is described with a photograph. S.K.

Study of glass sand. I and II. YOSHIO SAKAMOTO. Asahi Glass Co., Ltd., *Research Rept.*, No. 14, pp. 13–28 (1925).—Chemical and physical properties of domestic and foreign glass sand have been determined. (*1*) *Foreign sands.* Sand of Fontainebleau is very pure, contains no grains over 0.5 mm., has only 1.10% by weight of grains smaller than 0.1 mm. and consists of colorless transparent quartz grains. It is almost ideal material for glass making. (*2*) *Japanese sands.* Sands of the Taikokuzan Islands and Kamiho in Korea are excellent in their quality and quantity. Tables I and II show that their impurities are chiefly in coarse or minute grains.

TABLE I

Chemical Composition of Taikokuzan Sand

Size of grains in mm.	Proportion %	Loss on ignition	Silica	Alumina	Ferric oxide	Lime	Magnesia	Tota
Over 1	0.50	6.61	80.42	4.00	0.66	6.71	0.26	98.66
1–0.5	0.83	1.40	95.24	2.13	0.42	0.71	0.15	100.05
0.5–0.1	97.11	0.36	96.27	1.85	0.35	0.33	0.13	99.29
0.1–0.01	0.37	4.50	84.37	8.31	0.80	0.94	0.42	99.34
Under 0.01	0.81	12.32	56.29	27.21	2.01	0.97	0.94	99.74

TABLE II

Chemical Composition of Kumiho Sand

Size of grains in mm.	Proportion %	Loss on ignition	Silica	Alumina	Ferric oxide	Lime	Magnesia	Total
Over 1	0.12	28.60	28.91	5.03	0.98	34.28	0.67	98.47
1–0.5	0.06	12.78	65.79	2.80	0.88	16.92	0.18	99.35
0.5–0.1	98.75	0.19	98.02	0.77	0.21	0.25	0.10	99.54
Under 0.1	0.79	15.98	63.99	13.94	2.82	1.64	0.64	99.01

Quality of the sands has been markedly improved by screening and washing. Kumiho sand contains only a little of mineral grains such as feldspar and mica which is rich in

sand of Taikokuzan. Grains of Kumiho sand are covered with thin film of iron oxide which can be removed with HCl as Table III shows.

TABLE III

Chemical Composition of Kumiho Sand before and after Treating with HCl

	Loss on ignition	Silica	Alumina	Ferric oxide	Lime	Magnesia	Total
Before treatment	0.37	97.91	0.60	0.31	0.24	0.20	99.63
After "	0.10	99.55	0.20	0.08	0.03	0.02	99.98

Study of glass sand. III. Process of removing iron from silica sand with chlorine. *Ibid.*, No. 17, pp. 56–64 (1927).—Kumiho sand which is used in the concern was treated with chlorine at various temperatures with following result:

Temperature	Time	Raw sand		After treating with chlorine	
(°C)	(hr.)	Total Fe_2O_3 (%)	Fe_2O_3 sol. in HCl (%)	Total Fe_2O_3 (%)	Fe_2O_3 sol. in HCl (%)
800	1	0.34	0.31	0.26	0.23
900	1	0.34	0.31	0.13	0.10
1000	1/4	0.34	0.31	0.09	0.06
1000	1/2	0.34	0.31	0.06	0.03
1000	1	0.34	0.31	0.05	0.02

S.K.

Milky white substance produced in glass. HIROTARO OTA AND YOSHIO SAKAMOTO. Asahi Glass Co., Ltd., *Research Rept.*, No. 14, pp. 45–59 (1925).—A milky white substance was observed in glasses after heating long above 1500°C and cooling rapidly. The sample was a window-glass cullet, composed of silica 71.38, alumina 0.98, ferric oxide 0.35, lime 14.36, magnesia 0.29, and soda 12.64, in one case and a batch made of 100 g. of Kumiho sand, consisting of loss on ignition 0.37, silica 97.91, alumina 0.60, ferric oxide 0.31, lime 0.24, and magnesia 0.20, 35 g. of chemically pure sodium carbonate, and 33 g. of calcium carbonate. The milky white substance was found especially on the surface of glass close to the crucible wall. It is dispersed in the glasses finer than gold in ruby glasses, and disappears when the glasses are heated to 800°C for 30 min. or 900° for 5 min. Analysis of the transparent glass and milky white portion shows no marked differences. O. and S. explain the phenomena by allotropic changes in such glass constituents as silica and dicalcium silicate. S.K.

Weathering and durability of glass. KIYOSHI UEDA. Asahi Glass Co., Ltd., *Research Rept.*, No. 17, pp. 39–55 (1927).—(1) Durability and density of a glass increase with the progress of annealing. (2) The surface of annealed glass is far more durable than its interior. (3) A cleaned glass, consisting of SiO_2 69.43, CaO 11.49, Na_2O 16.46, Fe_2O_3 and Al_2O_3 1.46, MgO 0.66, and SO_3 0.63, was heated at 600°C for 30 min. in the current of acidic gas or vapor. After cleaning, it was placed in moist air at 60°C until it was permanently dimmed (Table I).

TABLE I

Action of Gases and Vapors at 600°C

Gas or vapor	Time required for permanent dimness	Gas or vapor	Time required for permanent dimness
Untreated glass	1	HCl	21
Air	3	H_2SO_4	21
Steam	3	CO_2	22
Combustion gases from coal gas	4	Br	23
SO_2	10	NO	25
H_2S	21	HNO_3	25
Cl	21	H_2SO_3	35

The same glass was exposed to the action of various reagents and tested for its durability (Table II).

TABLE II

Action of Vapors and Liquid below 600°C

Reagents	Time required for permanent dimness in days
Cold HNO_3 for 10 days	2
Cold fuming sulphuric acid for 10 days	2
Boiling *N* Na_2CO_3 solution for 3 hrs.	2
Steam of 100°C for 1 hr.	6
Concentrated H_2SO_4 of 130°C for 3 hrs.	7
Boiling 1% H_3PO_4 for 3 hrs.	10
Boiling water for 3 hrs.	13
Boiling 5*N* HCl for 3 hrs.	14

To find the action of various reagents under pressure, the glass and each reagent were sealed in a test tube and heated at 120°C for 3 hrs. (Table III).

TABLE III

Action of Reagents under Pressure

Reagents	Time required for permanent dimness in days
CO_2 dry	1
CO_2 moist	6
SO_2 dry	2
SO_2 moist	12
HCl dry	4
HCl moist	7
Water	13

5 g. of the said glass ground to 0.5–1.0 mm. size were boiled in distilled water to find its action on the glass (Table IV).

TABLE IV

Action of Water

Time of boiling (hrs.)	Loss on drying		Alkalis dissolved in Na_2O
	100°C	100°–500°C	
1	6.8 mg.	—	2.7 mg.
2	10.9	0.3 mg.	4.0
3	13.3	0.7	5.1
5	13.8	1.1	5.0
7	16.2	1.4	6.1
10	19.3	1.6	6.7

The result indicates that water penetrates to the interior of the glass on long boiling.

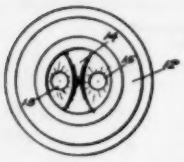
S.K.

PATENTS

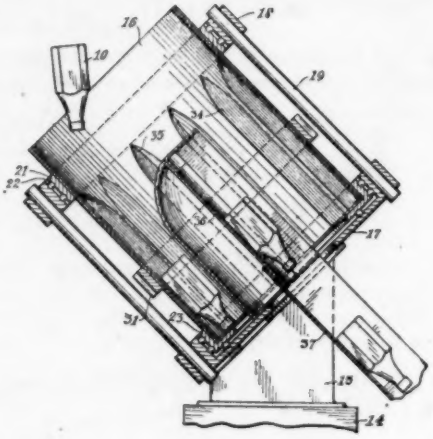
Means for conveying molten glass to molds. LEONARD D. SOUBIER. U. S. 1,653,477, Dec. 20, 1927. The combination of a mold open at its lower end to receive a charge of glass, means to separate an individual mass or charge from a supply of molten glass, and means to introduce the separated charge into the mold through said lower open end thereof, said means comprising a passageway into which the separated charge is dropped and through which it moves to the mold.

Glass feeder. LEONARD D. SOUBIER. U. S. 1,653,478, Dec. 20, 1927. The combination of a container for molten glass, a stationary discharging receptacle having an outlet orifice, and a transfer receptacle between the container and discharging receptacle, the container having an outlet through which molten glass issues in a continuous stream into the transfer receptacle a power element, and means automatically operated thereby for periodically actuating the transfer receptacle to discharge the glass into the discharging receptacle.

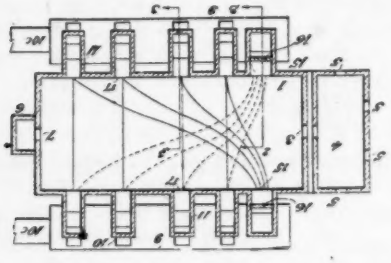
Glass feeder. LEONARD D. SOUBIER. U. S. 1,653,479, Dec. 20, 1927. The combination of a container for molten glass having a plurality of outlet openings through which the glass issues, means opening into the container to permit a flow of glass into the container and maintaining a continuous supply of glass within the container, a single device controlling the glass issuing from the openings, and automatic means to actuate the device and cause it to periodically exert an expelling force on the glass.



Conveying apparatus. LEONARD D. SOUBIER. U. S. 1,653,480, Dec. 20, 1927. The combination of a machine having means for discharging a plurality of articles at a time, a drum to receive the articles, an article guiding member within the drum, spaced therefrom and presenting a surface parallel with the inner surface of the drum to provide a passageway for the articles, means to rotate one of the parts about the axis of the drum while the other part remains stationary and provides a guiding surface for the articles, and spaced ribs in the passageway moving with the rotating part for positioning, spacing and driving the articles.



Regenerative furnace for melting glass. ROBERT D. PIKE. U. S. 1,653,507, Dec. 20, 1927. A regenerative tank furnace for melting glass comprising a glass tank, a plurality of fuel and air ports in each of the longer sides of the tank, a regenerative chamber having communication with the ports, means for admitting glass to the tank at one of the shorter sides thereof, a supplemental passageway connecting each regenerative chamber with the interior of the tank at a point remote from the glass intake and means for controlling ports and passageways to cause the products of combustion to move diagonally across the furnace leading away from the glass inlet.



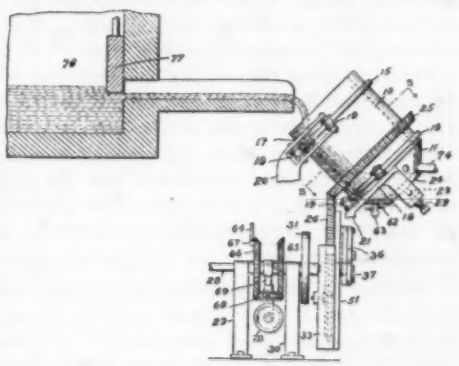
Bottle-making machine. JOHN J. MEYER, JR. AND JOHN G. LEPPER. U. S. 1,653,723, Dec. 27, 1927. The combination with a blank mold and means for opening and closing it, of a bottle finishing mold arranged in radial alignment with the blank mold and below it, said blank and finishing molds being movable about a common axis, together with means for opening and closing bottle finishing mold, a die arranged in the blank forming mold and pneumatically operated means for swinging the die from the blank mold over into alignment with the bottle finishing mold and simultaneously opening the same to release the blank, a blow head in operative relation with the bottle finishing mold, and pneumatically operated bottle lifting fingers adapted to remove the finished bottle from the bottle finishing mold when opened.

Method and apparatus for making glass tubing. SIDNEY S. GROTTA. U. S. 1,653,848, Dec. 27, 1927. (1) Apparatus for forming glass tubing comprising a container for molten glass having a discharge opening of uniform cross-section area from its inner end for part of its length, and then gradually enlarging in cross-sectional area for the remainder of its length, a mandrel extending through the discharge opening in spaced relation to the wall thereof and coöperating with the wall of the discharge opening to produce an annular discharge outlet for glass from the container, the mandrel having an enlarged outer end portion, and means for adjusting the mandrel axially of the discharge opening to vary the thickness of the stream of glass issuing from the discharge outlet. (2) The method of forming glass tubing, which comprises passing molten glass from a supply body in an annular stream of substantially uniform diameter, then passing glass from the outer end of the stream in an outwardly enlarging frusto-conical stream, cooling it externally, finally passing glass from the larger end of the frusto-conical stream in the form of a tube of substantially uniform diameter, and introducing cooling fluid into the tube.

Apparatus for handling glassware. KARL E. PEILER. U. S. 1,654,091, Dec. 27, 1927. In glassware handling apparatus, the combination with a rotating ware holder, of a take-out device mounted to rotate about an axis spaced from that of the holder and adapted to move substantially in coincidence with the ware for a finite distance while approaching take-out position and arranged to engage and carry the ware from the holder.

Plate-glass manufacture. FRANK S. WHITLOCK. U. S. 1,654,198, Dec. 27, 1927. The method of forming glass sheets comprising forming a gob of greater extent horizontally than vertically, and catching the gob in its descent to increase its vertical extent both upward and downward from the point of catching.

Method and apparatus for melting glass. PETER KUCERA. U. S. 1,654,591, Jan. 3, 1928. The method of forming mold charges of molten glass, which consists in rolling a batch of molten glass in one direction, delivering successive quotas of molten glass from different parts of the batch, severing the quotas from the batch and retracting and reincorporating the severed stubs in the batch by the rolling action.



Timing mechanism for glass-feeding apparatus. OLIVER M. TUCKER AND WILLIAM A. REEVES. U. S. 1,654,710, Jan. 3, 1928. In pneumatic timing mechanism for glass feeding apparatus, a plurality of valves, a rotary cam for actuating each valve, common driving means for rotating the cams to actuate the valves, intermediate gearing between the driving means and one of the cams, and manually operable means for adjusting the gearing to change the angular position of one cam relative to another and thereby to change the relative time of actuation of the corresponding valves.

Glass-blowing machinery. HENRY W. INGLE. U. S. 1,654,731, Jan. 3, 1928. In glassworking apparatus the combination with a mold, a funnel mounted for movement into and out of operative position relative to the mold, and a device mounted for movement into operative position relative to the funnel when it is in operative position relative to the mold to apply settle blowing pressure therethrough and into operative position

relative to the mold when the funnel is out of operative position relative thereto to provide a bottom closure therefor.

Manufacturing glass. AUGUST KADOW. U. S. 1,654,817, Jan. 3, 1928. In the manufacture of glassware, the process which consists in forming a set shape of molten glass, severing the set glass by melting it along the line of severance so quickly that severance results and leaves the glass constituting the severed edge of the finished article in substantially its original position with regard to the portion of the article to which it is attached, and thereafter raising the temperature of the glass for annealing purposes, and finally allowing it to cool.

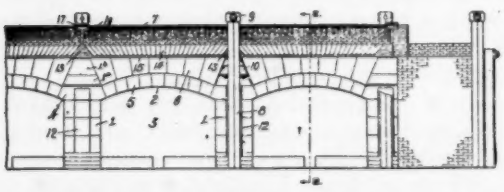
Feeding glass into molds. AUGUST E. LIEPOLD. U. S. 1,655,190, Jan. 3, 1928. An apparatus for feeding gobs of molten glass into molds comprising a receptacle having an outlet orifice, means for opening and closing the outlet, means for continuously supplying molten glass to the receptacle, means for imparting a vertical movement to the receptacle, and severing means operated by the receptacle moving means, severing being carried by the receptacle and located adjacent the outlet orifice.

Machine for treating hollow glass articles. ROSCOE G. PHELPS AND LUDWIG STAUDENMEIR. U. S. 1,655,290, Jan. 3, 1928. In a machine for treating the inside surfaces of hollow glass articles, the combination of a carrier provided with means for receiving an article, a fluid container having a nozzle adapted to discharge into the article when in registry therewith, and mechanism for moving the carrier to cause a substantially longitudinal reciprocation of the article relatively to the nozzle during the fluid discharging period.

Method of and apparatus for feeding molten glass. KARL E. PEILER. U. S. 1,655,391, Jan. 3, 1928. In the manufacture of glassware, the method of delivering, to successively presented molds, continuous series of similar and compact charges of molten glass of shape and weight appropriate to the particular molds to be fed, which method comprises superimposing a sufficient head of molten glass, of proper viscosity for suspension in mold-charge masses, upon a delivery orifice of a proper contour and area to permit the feeding of charges appropriate to the molds to be fed, and, for each mold charge, discharging the glass through the orifice, reciprocating a discharge-controlling implement toward and from the orifice to determine selectively the shape of the discharged glass suspended beneath the orifice, and severing a mold charge from the discharged glass before the shape imparted to the discharged glass is lost and before the discharged glass receives any substantial under-support.

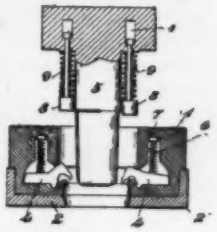
Method of and apparatus for feeding molten glass. KARL E. PEILER. U. S. 1,655,392, Jan. 3, 1928. In an apparatus for separating molten glass into mold charges, the combination with a container for the glass communicating with the atmosphere above the surface of the glass and having a submerged discharge outlet, of means for periodically varying the depth of glass over the outlet, and severing means beneath the outlet operating in timed relation to the depth varying means.

Furnace construction. DAVID H. GOODWILLIE. U. S. 1,655,680, Jan. 10, 1928. (1) A furnace structure of the class described, having an arched roof and a side arch portion, and means independent of the arch portion for supporting the roof, including uprights without the arch portion and thrust means along the edge of the roof adapted to concentrate the roof load at points opposite the uprights and to distribute

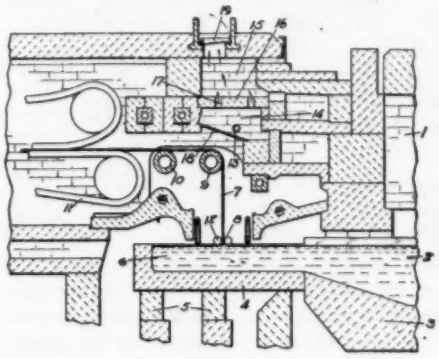


the load thereto. (2) A furnace of the class described, comprising a side structure composed of longitudinally spaced pillars and arches built up of refractory blocks, a roof structure having its edges meeting the upper edges of the side structure,buckstays at the outer sides of the pillars, means bracing the buckstays, a bracket carried by each buckstay in elevated position and in turn carrying the upper portion of the associated pillar, and means built into the side edge portions of the roof structure and concentrating the roof load on the brackets through the pillar portions carried thereby.

Mold head for the formation of a fissure in the mouth of glass bottles or porcelain, etc. FELIPE OBIOL. U. S. 1,655,917, Jan. 10, 1928. In a device of the character described, the combination of a head member and a dividing cap embracing the under face thereof, a reciprocating plunger operating through the head to form the internal surface of a bottle neck, spring operated sectors fulcrumed in the head and arranged radially of the axis thereof, and yieldable plungers of alternately different lengths and carried by the reciprocating plunger to engage the sectors and press the latter into the lip of the bottle neck to form an internal circumferential groove therein.



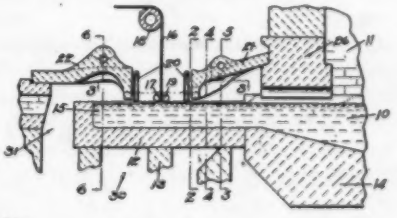
Laminated glass. HORACE E. ALLEN. U. S. 1,655,933, Jan. 10, 1928. As a new article of manufacture, a sheet of laminated glass comprising a sheet of glass, a skin thereon, a film of tetralin, and a sheet of nonbrittle material.



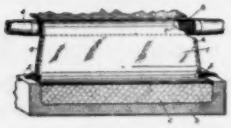
Bending-chamber fire box. LEWIS D. BLACKSHERE. U. S. 1,655,934, Jan. 10, 1928. In sheet glass apparatus, means for drawing a sheet from a mass of molten glass, means for deflecting the sheet from one plane to another, a gas burner arranged in proximity to the sheet where it is being bent, and a radiating plate between the burner and the sheet, the plate being spaced from but parallel to a plane tangent to the curved path traversed by the sheet while the sheet is being bent from a vertical into a horizontal plane.

Annealing leer. JAMES C. BLAIR. U. S. 1,655,935, Jan. 10, 1928. In sheet glass apparatus, an annealing leer, means for supporting a sheet therein, a plurality of baffles arranged above the sheet and being progressively shorter from the hot end of the leer toward the cold end thereof and a plurality of burners arranged within the leer beneath said sheet.

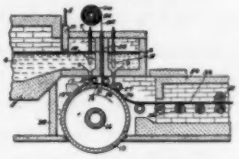
Glass apparatus and lip tile therefor. ENOCH T. FERNGREN. U. S. 1,655,992, Jan. 10, 1928. In sheet glass apparatus, means for drawing a sheet from a mass of molten glass, and a tile arranged above the glass, the center portion thereof being relatively closer to the glass than the sides to permit a greater volume of heat above the side portions of the glass than in the center.

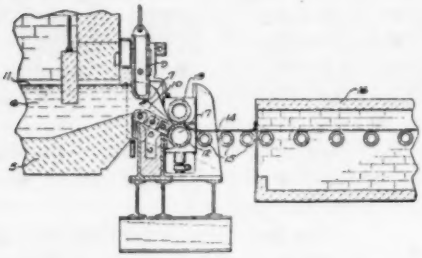


Bending roller for drawn sheet glass. CHARLES TRUELOVE AND WILLIAM T. HAIGHT. U. S. 1,655,924, Jan. 10, 1928. In an apparatus for drawing sheet glass, a roller about which the sheet is deflected from one plane to another, the roller comprising a central portion and freely rotatable end portions adapted to carry the edge portions of the sheet, the end portions of the roller being knurled.



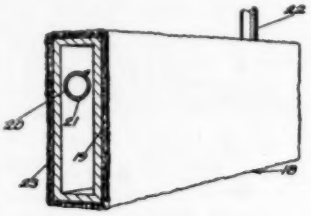
Wire-glass machine. JOSEPH P. CROWLEY. U. S. 1,656,048, Jan. 10, 1928. In sheet glass apparatus, a rotatable member, means for flowing a plurality of streams of molten glass thereon, and means for drawing a sheet therefrom.



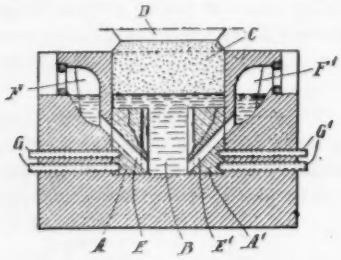


Sheet-glass apparatus. JOHN L. DRAKE. U. S. 1,656,102, Jan. 10, 1928. In sheet glass apparatus a receptacle containing a mass of molten glass, a pair of rolls between which the glass passes in sheet form, the sheet having greater contact with one of the rolls than the other, the wall of the roll having greater contact with the sheet being relatively thinner than the wall of the other roll.

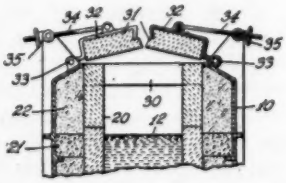
Cooler for sheet-glass apparatus. JOHN L. DRAKE. U. S. 1,656,103, Jan. 10, 1928. A cooler adapted for use in sheet glass apparatus, comprising a hollow metallic casing and an asbestos covering for it.



Electric furnace for melting or producing glass, water-glass, cement, or other substances. CORNELIUS ERIK CORNELIUS. U. S. 1,656,510, Jan. 17, 1928. An electric furnace for melting or producing glass, water-glass, cement, and other substances, in which the substance which is melted or produced forms a resistance for the electric current, comprising solid metal electrodes having a large heat accumulating capacity in relation to the substance to be treated.

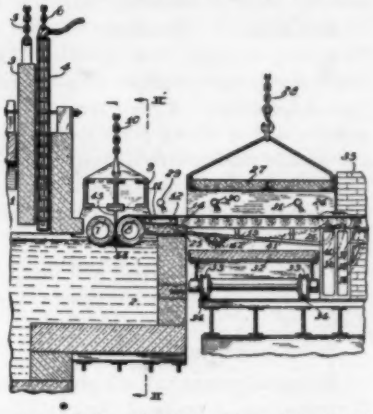


Feeding molten glass. KARL E. PEILER. U. S. 1,656,869, Jan. 17, 1928. Apparatus for feeding molten glass, comprising a container through which the glass may flow, the container having an opening disposed above the glass line therein, a sectional cover adapted to close the opening, and means for independently opening the sections of the cover to a regulable extent to control the radiation of heat of certain portions of the flowing glass.



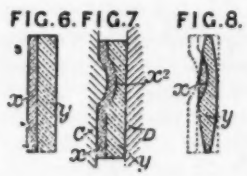
Apparatus for making plate glass. FREDERICK GELSTHARP. U. S. 16, 856, Jan. 17,

1928. In combination, a glass tank containing a body of molten glass, and open above a portion of the body, a pair of horizontal driven and cooled sizing rolls seated above and having the lower portions of their peripheries immersed in the body of glass, and a glass receiving bed extending laterally from the side of one of the rolls for carrying away the glass which is formed.



Unbreakable glass. F. THIEL, A. VACHA, AND F. J. GOLDSCHMIDT. Brit. 279,031, Dec. 7, 1927. Unbreakable glass sheets for lamp-shades, dishes, etc., are made by applying a transparent or translucent varnish to both surfaces of a transparent or translucent celluloid or like sheet and at the same time small particles of glass uniformly distributed.

Glass manufacture; lenses. C. B. USTONSON. Brit. 279,322, Dec. 14, 1927. Relates to a method of making glass articles which are composed of two glasses, fused together, having different characteristics, such as lenses or light filters. According to the invention, superposed layers (x, y) Fig. 6, of different kinds of glass are pressed, when hot and plastic, between a pair of die members (C, D) Fig. 7, which are so shaped as to cause a portion (x^2) of one layer to be displaced into the plane of the other layer. The combined layers are ground, as shown in Fig. 8, to produce a bifocal spectacle lens, a head lamp lens for motor cars, or other article. Glasses may be combined in this way to produce a light filter of different colors or with graduated tints.



Heavy Clay Products

Strength of brick in tension. J. W. MCBURNEY. *Jour. Amer. Ceram. Soc.*, **11** [2], 114–17 (1928).—A self-aligning grip for use in testing brick in tension is described. Values for the tensile strength of several types of brick are given. Comparison is made between the transverse and tensile strength of the brick. The conclusion is that the tensile strength is closely related to the transverse strength.

Standard specifications and tests for hollow fired clay load-bearing wall tile. *A.S.T.M. Stand.* (Series C34–27), pp. 213–18 (1927).—Under these specifications are given application, classification, weights, dimensions, weathering resistance, fire resistance, workmanship and finish, marking, inspection, and rejection. Under "tests" are described sampling, weight determinations, strength, absorption, and freezing tests. R.A.H.

Standard specifications and tests for hollow fired clay floor tile. *A.S.T.M. Stand.* (Series C57–27), pp. 219–23 (1927).—Under these specifications are given application, classification, weights, dimensions, fire resistance, workmanship and finish, marking, inspection, and rejection. Under "tests" are described methods of sampling, weight determinations, strength tests, and absorption tests. R.A.H.

Paving brick. Simplified Practice Recommendation No. 1. Dept. of Commerce, 1927.—Describes the steps toward elimination of waste in industry by simplification as applied to paving brick, and how the number of shapes of brick was reduced from 60

to 4. Summaries are given of what was accomplished by the 1st, 2nd, 3rd, 4th, 5th, and 6th revision conferences. R.A.H.

Corrosion in chimneys. ANON. *Brit. Clayworker*, **36** [428], 258 (1927).—Gases containing sulphur, lead, arsenic, chlorine, or fluorine all tend to corrode brick work, especially in the presence of moisture, but carbonic acid and nitrogenous gases are almost harmless. A high temperature in the chimney prevents condensation of the gases which is one of the most serious causes of corrosion. Ordinary building brick are seldom resistant to corrosive acids, but pressed bricks with a crushing strength of 250 T. per sq. ft. are usually satisfactory in this respect. Various methods and materials which may be used to overcome or aid in resistance of chimneys to acid corrosion are outlined. R.A.H.

Dies for wire-cut brick and tile. ANON. *Brit. Clayworker*, **36** [428], 264 (1927).—A discussion on some of the causes of laminations in extruded shapes and how to correct them. R.A.H.

Brick maker in Cologne. ANON. *Tonind. Ztg.*, **51** [74], 1339–40 (1927). F.P.H.

Electrical power in brick plants. KÖPEKE. *Tonind. Ztg.*, **51** [74], 1345–46 (1927).—A comparison is made of the cost of electrical and steam power used in brick plants. F.P.H.

Historical development of brick sizes. ANON. *Tonind. Ztg.*, **51** [74], 1349–50 (1927). F.P.H.

Determination of compressive strength. GROOTHOFF. *Tonind. Ztg.*, **51** [78], 1418–20 (1927).—A report of a study of the effect of the variation of the cross-section area and height of test pieces of building brick and sand lime brick on the determined compressive strength. The following types of test pieces are investigated: (1) test pieces of cross-section 70 x 70 mm. and of varying height; (2) test pieces of 120 x 120 mm. cross-section and of varying height; (3) cylindrical test pieces of 36.6 mm. diameter and of varying height. The percentage variations are between –30 to 150% depending mainly upon the height of the test pieces. The effect of mortar joints is discussed. F.P.H.

Controlling processes in clay products manufacture. ANON. *Brick Clay Rec.*, **71** [12], 848–62 (1927).—Devices or instruments for aiding in the regulation of manufacturing processes are numerous. The various branches of the ceramic industry are quite similar in the respect that they all employ heat to process their wares. But besides heat there are furnace atmosphere, draft, humidity, pressure, and other properties which play an important part in the production of ceramic products. To be able to reproduce the exact conditions of each of these properties means that one ought to be able to reproduce quality of ware. It is apparent then that the subject of control devices is important because their part is exactly that of aiding in the manipulation of equipment so that certain conditions can be exactly reproduced in the processing of ware with least expenditure of fuel and labor. Material is presented to acquaint the reader with (1) reactions and conditions occurring in the various processes in the manufacture of clay products; (2) practical applications of control devices and experiences drawn from the industry; (3) descriptions of devices applied in these processes. The reactions and conditions involved in drying, firing, producer gas and oil firing are discussed in detail. E.J.V.

Brick and brickmaking in the U. S. GEORGE M. FISKE. *Clay-Worker*, **88** [5], 365–67, [6], 456–58 (1927).—The evolution of brick-making machinery is discussed. A sketch of J. W. Penfield, the first man in the U. S. to design, build, and put into operation a machine for making stiff-clay brick and land drain tile, is given. The development of machinery from the original plunger machine built in 1853 is traced, showing

how changes in power and design have increased capacities. Single stream, end-cut brick, laminations, uniform tempering, dry-pan grinders, automatic cutters, end-cut brick, board delivery cutters, etc., are subjects also discussed. The development of the Chambers machine, first put in operation in 1862, is taken up, with a description extracted from the catalog of the Chambers Brothers Co. For previous articles see *Ceram. Abs.*, **6** [11] 517 (1927). E.J.V.

Advantages of shale or clay planer in pit operation. ANON. *Clay-Worker*, **88** [5], 356–58 (1927).—The plants of the P. Bannon Sewer Pipe Co., and the P. Bannon Brick and Tile Co., Louisville, Ky., have been using a shale and clay planer for approximately 7 years in winning their clay. The planer has proved dependable, economical, easy to operate, durable and very satisfactory in all respects. It averages the material and cuts it to such a fineness that it reduces by nearly 50% the usual grinding and screening requirements. The machine used is described. The brick and tile plant, a 15 down-draft kiln plant producing 100 T. of hollow ware daily, cannot keep up with its orders. The operation of the plant is discussed. Of special interest is a round downdraft 28-ft. kiln, used for rush orders, which can be fired in $3^1/_2$ days with natural draft. E.J.V.

Brick buildings at less cost. W. D. RICHARDSON. *Clay-Worker*, **88** [6], 460 (1927). The question of most vital concern to the brick-making industry today is the reduction of the cost of the brick wall. The simplest method of reducing the cost of bricklaying would be to make larger brick. In Germany it has been proposed to increase the size of the brick to reduce the cost of brick structures, and there the brick are already larger than the American. It is not advocated to change the length or width of the American standard brick, but the thickness or height could be made greater, to practically twice that of the present standard. R. believes that the thicker bricks are coming as an economical necessity and presents to brick manufacturers this practical solution of the problem. E.J.V.

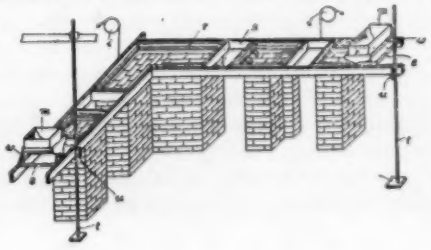
Factory design and equipment. X. T. W. GARVE. *Clay-Worker*, **88** [6], 448–50 (1927).—Various processes of firmly consolidating and bringing the plastic clay or clay mixture into the desired shapes are discussed. These include molding by hand, by machinery, soft-mud process, stiff-mud process, dry press process, and wet processes. Each is taken up in detail and the particular field of use of each is given. For previous article see *Ceram. Abs.*, **7** [2], 80 (1928). E.J.V.

Brick, the superstructure. ANON. *Clay-Worker*, **88** [6], 437–38 (1927).—A description of Indiana's World War Memorial Building at Indianapolis, in which over 6,000,000 brick, aggregating approximately 21,000 T., will be used in the superstructure. E.J.V.

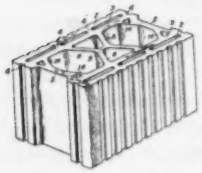
The brick industry's greatest handicap. J. J. STEIN. *Clay-Worker*, **88** [6], 446–47 (1927); *Brick Clay Rec.*, **72** [1], 24–27 (1928).—A paper presented at the annual convention of the American Face Brick Association at Hot Springs, Va. The greatest handicap of the brick industry lies in the mass of misinformation and ignorance, the inefficiency, and obstacles that so completely surround the important stages of placing brick in the wall after delivery to the building site. The "new competition" is just another way of saying that it must be the chief concern of brick men that the products they make are made available to the building public at a minimum of cost. E.J.V.

PATENTS

Apparatus for use in erecting walls of blocks, brick, etc. LUDWIG LIEDLER. U. S. 1,653,863, Dec. 27, 1927. Apparatus for use in erecting walls of stone or like blocks and rough plaster, comprising a



template entirely surrounding the horizontal cross-section of the wall being constructed longitudinally and transversely of the wall, and horizontal guide ledges mounted on the internal faces of the template to engage the blocks.



Building tile. PHILIP H. BEVIER. U. S. 1,654,631, Jan. 3, 1928. A tile having parallel side walls and transverse vertical webs connecting the parallel side walls, a short longitudinal web centrally located between the walls and diagonal webs connecting opposite ends of the short web with the side walls intermediate the ends thereof and at a substantial distance from the vertical webs.

Hydraulic brick press. FRANCIS E. STEVENSON. U. S. 1,654,761, Jan. 3, 1928. A press comprising a plurality of containers for materials, a mixing tank, means for intermittently conveying measured quantities of the materials into the mixing tank, a feeding tank communicating with the mixing tank and having a plurality of feeding openings therein, and a charging device having a plurality of compartments which alternately register with corresponding openings.

Refractories

Review of the literature on laboratory slag tests for refractories. ROBERT F. FERGUSON. *Jour. Amer. Ceram. Soc.*, **11** [2], 90–98 (1928).—A critical description is given of the numerous laboratory tests which have been proposed to determine the resistance of refractories to slag action.

Results of tests on tank blocks. BUREAU OF STANDARDS. *Amer. Glass Rev.*, **47** [10], 16 (1927).—Results of some tests on glass tank block corrosion are given. The test consists of melting 400 lbs. of glass per day for 30 days at an average temperature of 1400°C. The tank is made of clay blocks and special refractories as andalusite, mullite, and sillimanite. Porosity and relative pore sizes are determined on cylindrical specimens approximately 2 in. in diameter and 3 in. high with the following results:

		Pore Size		
Block	Porosity %	Large after 20 min.	Medium after 72 hrs.	Small after boiling
A	28	90	3	7
B	30	88	2	10
C	26	91	4	5
D	22	90	2	8
E				
F				
G	10	92	2	6

A preliminary petrographic examination of the various blocks gave the following information: (A) Clay block; mostly small poorly developed mullite with interstitial glass. (B) Mostly corundum and andalusite, with smaller amounts of mullite, quartz, and a little glass. (C) Very minute crystals of mullite in glass, with centers of undissociated cyanite grains. (D) Clay block; minute crystals of mullite imbedded in much glass showing much solutioning of quartz. (E and F) Corundum with some glass, containing minute crystals of mullite. (G) Coarse grains of mullite and corundum with interstitial glass. Blocks E and F show the least amount of corrosion. Of the special refractories, C showed the greatest amount of corrosion, the surface being badly pitted and of a spongy character. It is thought that blocks A, C, and D showed the least amount of resistance to attack due to the poor development of mullite and a larger amount of interstitial glass in combination with a relatively high porosity. It was found that the physical structure of the special refractories had a direct relation to their resistive powers. Increase of firing temperature caused an increase in the per cent

volume shrinkage, bulk specific gravity, and modulus of rupture and a decrease in the per cent of porosity. P.F.C.

Properties of silica and fireclay products in relation to industrial usages. A. J. GREEN. *Chem. and Ind.*, **46,** 1182 (1927).—Specific gravity is not an infallible test, since brick of specific gravity 2.32–2.37, a high-grade figure, may contain tridymite and cristobalite, which play a part in low-temperature spalling. Graphs are shown of refractories under load from 4–75 lbs. per sq. in. when subjected to heat-treatment. Temperature diffusivity and thermal conductivity were discussed, and under the heading corrosion, etc., the influence of iron compounds, salty coals, and open-hearth furnaces was dealt with. Presented at the meeting of the Institute of Chemical Engineers, Dec. 8. H.H.S.

Special brick lines. ANON. *Brit. Clayworker*, **36** [428], 259–60 (1927).—The refractory materials used in coke ovens may be arranged in 4 groups: (*a*) silica brick for coking chambers; (*b*) fireclay brick for recuperators; (*c*) basic or aluminous fireclay brick for the most seriously attacked parts of gas producers; (*d*) fireclay brick of second class quality for the less affected parts of the structure. Factors causing destruction of ovens are: (1) Pressure created by the contents of the ovens. (2) Carbon monoxide which tends to decompose and deposit free carbon in the pores of the brick. (3) Steam whose action is distinctly adverse to brick probably because it produces a partial hydrolysis of the silicates in them. (4) Volatilized alkaline compounds in all parts of the oven where the temperature exceeds 800°C, which may react with the refractory materials. Discussion follows relative to desirable qualities of refractories for different sections of coke ovens. R.A.H.

The pyrometric cone equivalent or softening of refractories by heat. STUART M. PHELPS. Amer. Refrac. Inst., *Bull.*, No. 17 (1927).—The softening of a refractory material by heat is not as simple as one might expect. The changes that result from heat treatment are numerous and complicated. "Melting point" if used in its correct sense, can seldom be applied to refractories. All pure chemical compounds in a solid form that can be melted by heat will melt at a definite temperature. This melting point or temperature will always be the same, regardless of the rate at which they may be heated. This reasoning does not apply to refractories since they are mixtures of a number of chemical compounds. Each microscopic grain by itself melts at a definite temperature, but this is not the same for each constituent present. Upon gradually heating a clay containing such a variety of materials, it would be expected that various changes would occur as the temperature is increased, due to the melting of the constituents at different temperatures. While in the molten condition the fluxes attack the more refractory grains, taking them also into solution and form what is termed a glass. These degrading effects of some of the fluxes take place at a low temperature, but increase in activity as the temperature is increased. The glass formed by the flux varies in quantity and in refractoriness, depending on a number of conditions. This glass forms the bond between the refractory grains and therefore largely determines the properties or value of the clay. Mixtures, such as clays, upon being melted, undergo a number of changes, dependent on the temperature and time period. The same changes can be produced in a clay at a low temperature for a long period of time as can be effected at a high temperature for a short time. In comparison the pure chemical compounds are not so affected by the time used in heating, and will melt at the same temperature regardless of previous heating below the melting point. This difference in behavior makes it necessary to use a separate term to express the melting or softening of the materials by heat. The term "melting point" should be used only in connection with the pure compounds, but in the past it has often been used in connection with refractory materials. The misuse of this term, and the misunderstanding that has arisen

through such expressions as "softening point," "fusion point," has prompted the coining of the term "pyrometric cone equivalent," or abbreviated "P.C.E." As defined by the C–8 Committee of the A.S.T.M. the P.C.E. is "an index to the degree of fusion resulting in a cone of the material bending until the tip touches the plaque as a result of a definite heat treatment, in accordance with the 'Standard Method of Test for Softening Point of Fireclay Brick' (Series C-24) of the A.S.T.M." F.P.H.

Expansion of refractory brick. K. SCHÖNERT. *Arch. Eisenhüttenwes.*, **1** [5], 379–86 (1927); *Stahl u. Eisen*, **47** [50], 2129 (1927).—The variation of the coefficient of expansion of refractory materials with the temperature is considered. The expansions of the following materials are given: (1) silica brick, (2) clay refractories, (3) magnesite brick, (4) chromite brick, (5) Carborundum brick. F.P.H.

Complete tank block tests at Bureau of Standards. IX. ANON. *Ceram. Ind.*, **10** [1], 58 (1928).—The last of a series of 9 tests on glass tank blocks, included in an investigation by the Bureau of Standards on glass tank block corrosion, has recently been completed. The test consisted of melting 400 pounds of glass per day for 30 days at an average temperature of 1400°C. The last tank contained clay blocks furnished by two manufacturers, and so-called special refractories as andalusite, mullite, and sillimanite were furnished by 4 manufacturers. F.P.H.

Study of sagger losses. ANON. *Ceram. Ind.*, **10** [1], 64 (1928).—Because of the huge losses sustained annually by the ceramic pottery industry on account of the comparatively short life of the average sagger, the Bureau of Standards is conducting an investigation, the ultimate purpose of which is to increase the life of the sagger. The majority of pottery is fired at temperatures over 1000°C (1832°F) and, since it is obvious that various stresses are induced in saggers when going through a heating and cooling cycle during the firing of the pottery, it is essential to know what effect these stresses have on the materials making up a sagger body. In order to analyze the stresses which might cause the failure of saggers the following properties of the sagger clays have been studied while heated at 1000°C: (1) transverse breaking strength, (2) rigidity, (3) plastic flow. The cross-breaking strength was found to have increased, and the rigidity was found to have decreased greatly at 1000°C when compared with the results determined at room temperature. Plastic flow was exhibited by all clays at this temperature. The results of these tests now are being applied in the compounding of sagger mixes. F.P.H.

Present methods of investigating refractory material applied to the gas-works furnace. E. STEINHOFF. *Gas Wasserfach*, **70** [41], 989–93, [42], 1019–23 (1927); *Stahl u. Eisen*, **47** [50], 2129 (1927).—The following subjects are considered: (1) requirements of refractory brick, (2) determination of the coefficient of expansion of refractory brick by the method of Steinhoff and Nopitsch, (3) testing the volume stability of refractories (4) the load test, (5) heat conductivity, (6) action of gases on refractory brick, (7) suggestions for investigating mortars. F.P.H.

Chemical composition of "Kochi-stone." FUKUCHI AND WATANABE. *Jour. Geol. Soc. (Japan)*, **32** [379], 131–41 (1925).—"Kochi-stone" which was found at Kochi in the prefecture of Iwate and has been used as a refractory material, is probably a kind of zuniyite. The composition is as follows: silica 24.68, alumina 61.80, ferric oxide 0.60, lime 0.69, magnesia 0.10, fluorine 5.18, chlorine 2.91, and water 6.15. S.K.

Iron contained in quartzites of Ryojun and so-called "red-white quartzite." KOJI KATO. *Jour. Jap. Ceram. Assn.*, **33** [395], 511–13 (1925).—Ryojun quartzite is produced in Ryojun and Dairen districts, while "red-white quartzite" is the general name of the rock found in Bungo, Tamba, Wakasa, Iyo, Tosa, and Awa. Typical analyses of the quartzites are:

	Silica	Ferric oxide	Alumina
Ryojun quartzite	97.0	1.0	1.5
Red-white quartzite	97.0	2.0	0.5

The Ryojun rock belongs to the pre-Cambrian quartzite and originates in fine sea sand deposited with mud in a shoal of great width. "Red-white quartzite" originates in shale belonging to from Cambrian to Permian systems and not to sandstone. The rock consists of quartzite from red to blackish brown in color and white secondary quartz which penetrates the former in irregular fine veins or networks. All iron is contained as hematite. The rock seldom has chalcedon structure. That the rock is very suitable for the manufacture of silica refractories was found by Kyutaro Miyoshi in his study on a specimen of unknown locality, although the first large deposit was discovered by Sokichi Ko at the Tsukumi pass not far from the town of Usuki. S.K.

Fire brick and steel industry. KOJI KATO. *Jour. Jap. Ceram. Assn.*, **34** [397], 34–37 (1926).—Raw materials, qualities, and production of various fire brick manufactured in Japan are described and discussed, particular attention being given to their relation to the steel industry. S.K.

Thermal insulation of nonconductive brick used in furnace construction. I. YOSHIAKI TADOKORO. *Jour. Jap. Ceram. Assn.*, **34** [403], 312–20 (1926).—(1) Physical properties of heat-insulating brick made in the country are discussed. There are two kinds of brick, one for low temperatures and the other for high temperatures. (2) Physical properties of 4 different bricks made by T. and those on the market are compared. Physical properties of the commercial brick are partly shown in Table I.

TABLE I

No.	Presumed raw material	Refractoriness °C	Porosity %	Crushing strength at 600°C kg./sq. cm.	Crushing strength at 1000°C kg./sq. cm.
(1)	Diatomaceous earth and slag wool	1135	60.50	47.29	81.55
(2)	" " " " "	1130	58.23	29.68	15.55
(3)	Siliceous pumice	1350	73.73	15.33	17.69

(*a*) Insulation brick made by the Tobata Firebrick Works, Tobata; (*b*) H.S.K. Insulation brick made by the Insulation Sheet Mfg. Co., Kobe; (*c*) "Kokaseki," a siliceous pumice stone produced in the Island of Oshima. Thirty-three different bricks made by T. have been investigated. Conclusions: (*a*) Although low temperature insulating bricks have refractoriness ranging from 1000–1350°C, they can only be safely used for a temperature of 500°C or lower. (*b*) Refractoriness and safe temperatures of high temperature insulating bricks are 1600°C or higher and 1300–1400°C respectively. (*c*) Both kinds of the brick have insulating powers which are about 3 times as much as those of grog bricks. (*d*) The insulating power of the brick rises with increase in porosity within a wide range, beyond which it falls rapidly. (*e*) The brick with good insulating power has a porosity amounting to from 55 to 65%. (*f*) Quality of the brick should be measured by its thermal and temperature conductivities. S.K.

Method of determining modulus of rigidity of refractories. YOSHIAKI TADOKORO AND OTOKICHI SUGA. *Jour. Jap. Ceram. Assn.*, **34** [408], 550–60 (1926).—Modulus of rigidity of silica brick which has been determined by Kusakabe's apparatus was partly improved by T. and S. Descriptions of the construction of the apparatus and procedure of the experiment are given. The method of calculations is described with examples of silica brick. S.K.

Load test of clay refractories as a means of estimating their qualities. YOSHIAKI TADOKORO *Jour. Jap. Ceram. Assn.*, **35** [410], 149–65 (1927).—Results of the load tests on clay refractories at various temperatures are compared with other properties. The softening temperature of the grog brick used in the hearth of a blast furnace at the

Imperial Iron Works falls regularly with the increase in load or the decrease in the rate of heating. A part of the results obtained in various tests on the relation between the cracking tendency and the viscosity of stopper brick used at the same plant are shown in Table I.

TABLE I

Softening Temperature and Cracking Tendency of Stopper Bricks A and B.

	A	B
Color	Light pink	White
Specific gravity	2.814	2.601
Porosity	28.71%	27.24%
Coefficient of expansion (α) at 500°C	5.25×10^{-6}	5.00×10^{-6}
Temperature conductivity (k) at 500°C in C.G.S. unit	7.3×10^{-3}	5.3×10^{-3}
$\sqrt{k}$ at 500°C in C.G.S. unit	8.5×10^{-2}	7.3×10^{-2}
Softening temperature under the load of 10 kg./sq. cm.:		
Raised 5°C per min.	1190°C	1070°C
" 10 " "	1198	1080
" 15 " "	1210	1092
Modulus of rigidity (R) at 20°C in kg./sq. cm.	2.61×10^{5}	1.36×10^{5}
Cracking tendency $\left(\frac{\alpha \cdot R}{\sqrt{k}}\right)$	16.100×10^{4}	6.325×10^{4}

Conclusions: (*a*) the softening temperature of a clay refractory under load is a measure of its viscosity at high temperatures, (*b*) the cracking tendency times the viscosity at high temperatures = constant, *i.e.*, the tendency of cracking is small in brick with high viscosity. S.K.

Diaspore deposit in Toei district. TORU AKIZUKI. Korea, *Central Lab. Report*, **8** [4], 9–16 (1925).—A large deposit of diaspore has been discovered. The outcrop is impure and melts down at cone 33. Refractoriness of the mineral taken from inner strata is over cone 37. It is grayish white, speckled white and reddish brown, and holds countless small crystals with strong luster. Table I shows the analysis compared with diaspores of other localities.

TABLE I

Locality	Silica	Alumina	Ferric oxide	Potash	Soda	Ignition loss	Specific gravity
Toei	6.44	67.92	1.12	0.03	0.13	14.24	3.14
Nagano	4.20	80.32	1.02			14.38	3.26
Okayama	6.37	78.27	0.23			14.52	
Hiroshima	25.00	60.04	0.14			14.74	2.95

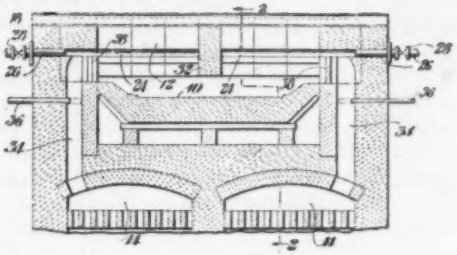
The result of the microscopical study indicates that it is diaspore with small proportions of quartz and ferric oxide. S.K.

PATENTS

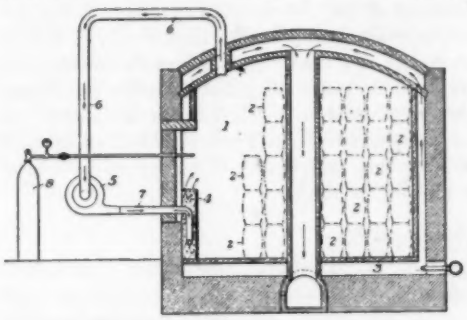
Refractory body and process for producing the same. MAHLON J. RENTSCHLER. U. S. 1,653,123, Dec. 20, 1927. The process of forming refractory bodies which comprises pugging together a mixture of clay, carbon particles, and heat-resistant particles, shaping the resultant mixture to suitable form, drying the mass of body thus produced, applying to the exterior of such mass or body a composition capable, when burned, of forming therewith a gas-excluding glaze, and firing such mass or body.

Producing a carbon-bonded refractory. EARL L. HAUMAN. U. S. 1,653,850, Dec. 27, 1927. Method of producing a stratified refractory product having a carbon bond in each stratum which consists in eliminating the carbon bond from parts of one stratum and making permanent the carbon bond in parts of the other stratum and incompletely removing the carbon bond in the merging sections or portions of the strata, the merging portions varying from no carbon in the one stratum to the maximum carbon bond in the other stratum.

Gas-fired furnace having tile burners. HENRY O. LOEBELL. U. S. 1,653,864, Dec. 27, 1927. A combined wall and burner having a surface comprised of a plurality of like ends of similar tile, formed to constitute a series of outwardly-flaring, relatively shallow pits, and passages in the tile opening on the bottom of the pits, the passages constituting conduits through which a combustible gaseous mixture may be introduced into the pits.



Silicon carbide article and method of making same. RICHARD H. MARTIN. U. S. 1,653,918, Dec. 27, 1927. (1) The method of forming a protective coating on a refractory article containing silicon carbide which comprises covering the article with a composition composed in large part of a magnesium compound, and thereafter appropriately firing the article to form a dense coating thereon substantially impervious to kiln gases under normal operating conditions. (2) A refractory article comprising a body containing silicon carbide and a protective coating thereover containing magnesia and ferric oxide, and being substantially impervious to kiln gases under normal operating conconditions.



Refractory article and process of making the same. ARTHUR J. JACKMAN. U. S. 16,845, Jan. 3, 1928. As a new article of manufacture, a refractory article consisting principally of graphite and a vitrifiable ceramic bond, and fired prior to use to a temperature above the vitrification point of the bonding material.

Process for treating aluminum-bearing ores. REED W. HYDE. U. S. 1,655,608, Jan. 10, 1928. The process of treating aluminum bearing material which consists in crushing the material to small particles, mixing the particles with particles of aluminate forming materials and with fine combustible material, placing the mixture on a support such that gases may be passed therethrough, igniting the combustible material at one surface of the mass, passing combustion-supporting gases through the mass to burn the combustible material and generate heat within the mass thereby driving off the water to form alumina, converting the alumina to a denser form and simultaneously causing the aluminate forming material to combine with a portion of the alumina, melting the compounds so formed and cooling them quickly to bind together the particles of alumina thereby forming a strong cellular cake.

Machine for making quartz-glass rods and tubes. ROBERT F. SCHALLER AND WILLIAM J. LIDLE. U. S. 1,655,846, Jan. 10, 1928. A machine for making an object of quartz glass, comprising a pair of spaced carriages movable toward and from each other, a pair of blocks movable upon the carriages in a common vertical plane, a pair of axially aligned shafts journaled in the blocks, means upon the facing ends of the shafts for engaging and supporting a nucleus of quartz glass between them, means for heating the nucleus to plastic state at one limit of movement of the nucleus, a receptacle for quartz powder adjacent the other limit of movement, each block having a lug thereon,

a rotating arm mounted on each carriage to engage the respective lug once during each rotation of the arms to move the respective block, means for rotating the arms in synchronism so that the blocks are simultaneously actuated to move the nucleus from the heating means into contact with the quartz powder, means for simultaneously rotating the shafts, means for actuating the blocks to move the nucleus away from the quartz powder to the heating means so that the quartz powder accretion is fused and incorporated into the nucleus, and means for moving the carriages apart to elongate the heated nucleus. (2) A machine for making an object of quartz glass, comprising a pair of spaced carriages movable toward and from each other and having threaded openings, a threaded shaft fitted in the openings so that rotation of the shaft moves the carriages toward and from each other, a pinion on the threaded shaft, a gear segment to mesh with the pinion to periodically rotate the shaft and move the carriages a predetermined distance, means for rotating the gear segment, a pair of axially lined rotatable supports on carriages to support a nucleus of quartz glass between them, means for rotating supports, and means for heating the nucleus to render it plastic.

Refractory substances. SOUTH METROPOLITAN GAS CO., AND R. H. B. LAMPREY. Brit. 278,821, Dec. 7, 1927. A refractory composition suitable for making gas retorts, etc., comprises tridymitic and quartzitic silica and fire clay which has been purified by elutriation and treatment with acid. The proportion of total silica to clay is such as to produce a desirable reduction of the shrinkage of the clay during drying and firing, the proportion of quartzite is sufficient to counteract the after-shrinkage occurring during use of the product, and the quartzite should be of a kind which undergoes modification into tridymite slowly. To avoid reduction of the softening point the silica should not be too finely divided; $^1/_8$–$^3/_8$ inch for the tridymite and $^1/_8$–$^1/_{40}$ inch for the quartz are suitable sizes. A typical composition consists of 40–45 parts of clay, 20–25 of calcined flint (No. 4–No. 8 mesh), 20–15 of calcined flint (No. 8–No. 12 mesh), and 20–15 of sand. Alumina or Carborundum may replace the sand.

Terra Cotta

Warpage study of terra cotta clays. R. M. MURPHY. *Jour. Amer. Ceram. Soc.*, **11** [2], 103–104 (1928).—Several types of clays, which compose a commercial terra cotta body, were studied for warpage during drying and firing. Results of warpage test show properties that each clay gives to the terra cotta body.

Specification of roofing tile. SEIJI KONDO. *Jour. Jap. Ceram. Assn.*, **33** [395], 508–11 (1925).—A short explanation and discussion on the specification of roofing tile recently established by the government committee are given with tables showing qualities of the tile made by most important manufacturers in Japan. S.K.

Coal-fired kilns used for roofing tile in the Ishikawa Prefecture. KYOTARO KOYAMA AND HATSUJI YOKOYAMA. *Jour. Jap. Ceram. Assn.*, **35** [410], 51–58 (1927).—Construction of the kilns used for roofing tile and cost of manufacturing them in the districts are shown with drawings and tables. Properties of their bodies are shown in Table I.

TABLE I

Properties of the Bodies

District	Chemical Composition							Refractoriness	Firing temperature
	Ig. loss	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	KNaO		
Nomi (semicontinuous horizontal kiln)	8.89	65.93	15.86	5.04	3.05	1.07	0.18	Cone 21	Cone 4a
Nomi (semicontinuous inclined kiln)	7.70	65.93	19.43	5.35	1.10	0.08	0.49	" 19	" 7
Nomi (semicontinuous inclined kiln)	6.43	65.74	20.81	4.54	1.52	0.17	0.81	" 19	" 7+
Kahoku (semi continuous inclined kiln)	7.98	64.63	20.69	2.93	0.79	2.12	0.86	" 13	" 6a+
Hagui (semicontinuous inclined kiln)	8.72	61.16	16.34	5.76	1.21	0.08	6.88	" 13	" 7
Hagui (semicontinuous inclined kiln)	8.05	62.11	20.25	6.57	1.76	0.92	0.34	" 12+	" 6a

Generally speaking, refractoriness of the bodies varies from cone 12 to 26; red or black glaze is applied on all surfaces of the soft biscuits which are glost-fired to cones 6a–9. S.K.

Japanese specification of roofing tile. *Jap. Eng. Stand. Comm.* (Dept. Comm. and Ind.), **30** [A6], 3 pp. (1927).—The specification covers three important kinds of blackish unglazed roofing tile which are made by firing with reducing flame and by cooling in the vapor of heavy hydrocarbons produced usually by the dry distillation of wood or coal. The standard shapes and dimensions are specified. The tile are graded as follows:

Grade		Shape	Defects	Max. absorption	Color	Sound
Both sides polished	A	Good	None	16%	Silvery	Clear metallic
" " "	B	"	"	18%	"	"
" " "	C	Common	Slight	20%	Somewhat-silvery	
One side polished	A	Good	None	18%	Silvery	Clear metallic
" " "	B	"	"	20%	Somewhat silvery	Clear
" " "	C	Common	Slight	22%	"	
Unpolished	A	Good	None	20%	Silvery	Clear
"	B	"	"	22%	Dark	
"	C	Common	Slight	24%	"	

The absorption test is specified. S.K.

"Gairome" clay. ISAMU KONO. *Jour. Jap. Ceram. Assn.*, **33** [395], 552–56 (1925).—Chemical and physical properties of "Gairome" clays, most important raw material of white wares in the country, are given. S.K.

Discolored roofing tile. ANON. *Master Builder*, [784], 60, Sept. (1927); *Tonind. Ztg.*, **51** [80], 1472 (1927). F.P.H.

Cribs of the Nativity. ANON. *Illust. London News*, **171**, 1144–45 (1927).—Cribs of clay or terracotta have been made since the earliest Christian times. Bethlehem cribs were brought to Rome by Pope Liberius in 354. The 15th to 18th centuries were the most brilliant epoch for these graceful works. Nine reproductions of cribs from Naples, Sicily, Munich, and the Tyrol are shown. H.H.S.

White Wares

The vacuum-slip process of removing air from clay bodies. G. W. LAPP. *Jour. Amer. Ceram. Soc.*, **11** [2], 61–67 (1928).—In this process the slip clay is passed through a tank and the air content is evacuated by boiling out. The ability of the clay filter cakes formed from this slip to reabsorb a small amount of air insures freedom from air in the pugged clay if the pug mill is efficient as it can be in compacting the clay, without adding appreciable air to the clay. Freedom from gases results in a series of helpful conditions throughout the various stages of production.

Use of fused silica as a raw material in the manufacture of porcelain. A. E. R. WESTMAN. *Jour. Amer. Ceram. Soc.*, **11** [2], 82–89 (1928).—The effect of different forms of silica commonly used in porcelain bodies on their properties is compared with that produced by use of fused silica. Sources of fused silica are discussed. Comparative tests were made on two bodies, typical of electrical porcelain commonly manufactured in the U. S., the only difference between them being that one contained Ottawa sand flint while the other contained powdered fused silica. The firing behavior and thermal expansions were determined and a microscopic examination of thin sections was made. The fused silica body differed materially from the porcelain and due to its difference the name "fusilain" has been suggested for it. A further investigation of other properties thereof is planned.

Length of time of die use as affecting the size of floor tile. ROLAND V. TAILBY. *Jour. Amer. Ceram. Soc.*, **11** [2], 105–106 (1928).—A description of a factory investigation to determine the practical life of dies used in pressing one-inch hexagonal tile.

Fundamental study of glaze fit. ANON. Bur. Stand., *Tech. News Bull.*, No. 128, pp. 3–4 (1927).—This investigation is being conducted to determine the effect of the various oxides on the tensile strength, modulus of elasticity, and coefficient of expansion of glazes. The Fizeau-Pulfrich method is being used for determination of linear thermal expansion and about 75% of this work has been completed. The mean coefficient of linear expansion has been calculated and found to vary from 0.0456×10^{-4} to 0.1581×10^{-4}. R.A.H.

Ceramic bodies represented according to mineral composition and as silicates. JOSEF WOLF. *Sprechsaal*, **60** [43], 785–89; [44], 807–10; [45], 827–30 (1927).—Molecular proportions of bodies are represented by dots in triaxial diagrams. The solution of this problem is shown graphically and by a series of tables on body composition. Each body that is composed of kaolin, feldspar, and quartz may be represented by the general formula: $x\ RO \cdot 1\ Al_2O_3 \cdot y\ SiO_2$ on which formula W.'s triaxial diagrams are based. R.A.H.

Homer-Laughlin production. ANON. *Ceram. Ind.*, **10** [1], 59–64 (1928).—A description is given of plant No. 7, equipped with the most modern pottery fabricating machinery and devices, and producing 6000 dozens china ware daily. Illustrated. F.P.H.

Effects of oxides on glazes. ANON. *Ceram. Ind.*, **10** [1], 68 (1928).—An investigation is being conducted at the Bureau of Standards to determine the effect of the various oxides on the tensile strength, modulus of elasticity, and coefficient of expansion of glazes. Factors applicable to the various oxides have been worked out for the modulus of elasticity and tensile strength of the glazes based on the batch compositions. The Fizeau-Pulfrich method, which has been in use for a number of years at the Bureau for the measurement of small dilatations, was used in determining the coefficient of linear expansion of the glazes. The extreme sensitiveness of the interferometer makes it possible to work with a small specimen of the material. The rods used in this work varied from 0.3 to 0.8 mm. in thickness. The small size of this apparatus simplifies the problems of uniform heating and temperature control. The heating rate used in this work was 3°C per minute. The temperature expansion curves obtained for the glazes are not strictly linear, as the slope increases slightly with the temperature. The mean coefficient of linear expansion has been calculated and is found to vary from $.0456\times10^{-4}$ to $.1581\times10^{-4}$. The former value is for a high magnesium glass while the latter is for a high soda-potash glass. F.P.H.

New methods in porcelain technique. GUSTAV KOPKA. *Keramos*, **6** [10], 375–77 (1927).—A description is given of the latest methods and equipment used in the manufacture of porcelain in Germany. F.P.H

The fired color of porcelain. E. BERDEL. *Keramos*, **6** [10], 379–80 (1927).—A discussion is given of the effect of raw materials and furnace atmosphere on the resulting fired color of porcelain. F.P.H.

The German porcelain industry in 1925, 1926, and the first part of 1927. ANON. *Keramos*, **6** [11], 421 (1927). F.P.H.

Sanitary ware and its evolution. OTTO MUCKER. *Tonind. Ztg.*, **51** [78], 1423–24 (1927).—The method of manufacture, formulas of bodies, engobes, and glazes are discussed in this article. F.P.H.

The study of glaze in the U.S. ANON. *Pottery Gaz.*, **52** [606], 1923 (1927).—A brief report of an investigation to determine the effect of the various oxides on the tensile strength, modulus of elasticity, and coefficient of expansion of glazes. The progress on various determinations is mentioned. Observations made during a study of crazing are that crazing may take place either as soon as the ware is removed from the kiln or several months after the body is removed from the kiln. This latter type is caused by

changes, which may take place in the body, such as rehydration, or by changes which may take place in the glaze, designated as "after working." E.J.V.

Some Dorset potteries. ANON. *Pottery Gaz.*, **52** [606], 1924–28 (1927).—A description of several potteries in the neighborhood of Poole, in Dorset. The Hamworthy Pottery produces white and enameled tiles, architectural fireplaces, hearths, and surrounds. The bisque firing is done in round kilns of the Wilkinson type, glazing with American type dipping machines, and glost firing in a Dressler tunnel kiln. Floor tiles in large variety are made at the Architectural Works, Carter and Co., Ltd., where a new tunnel kiln known as the Williamson type is being used. The mechanical features of the South Western Pottery of George Jennings, Ltd., are discussed. The hand-made, semi stoneware, mat-glazed wares of Carter, Stabler and Adams, Ltd., are spoken of very highly. This ware is known to the trade as "Poole Pottery." A small pottery operated entirely by 4 partners who share in all the work is known as the Sibley Pottery Co., of Wareham. The aim is to produce articles of artistic individualism. E.J.V.

Pottery for the Indian market. ANON. *Pottery Gaz.*, **52** [606], 1930–32 (1927).—A discussion of the development of pottery, first for use, then for beauty and use combined. Beauty by decoration of pottery was obtained in three ways, (1) by artistic attention to the shape of the vessel; (2) by application of ornament, from the scratching of lines to the molding of a figure upon the clay body; and (3) by use of color and glaze. The needs of the East are described. Practical pottery is needed. The importance of the decoration is stressed. Proverbs and other inscriptions are very appropriate on pottery for the Indian market and add to the selling qualities thereof. E.J.V.

Pottery Managers' and Officials' Association. ANON. *Pottery Gaz.*, **52** [606], 1939–40 (1927).—At the meeting held at Hanley, England, on Oct. 25, Harold J. Plant spoke on the subject of "Some Common Faults in Pottery Manufacture." The subject of low-solubility glazes was first taken up. The difficulties encountered in trying to make a glaze are discussed. Black ware is due to a reducing atmosphere in the oven, when the glaze is reduced by being smothered with smoke during the baiting period, or, where the ware turns black either during the glost fire or during the kiln fire, the causes may be more associated with faults in the body mixture or in the handling of the ware. A correct body mixture will almost entirely eliminate black ware from the kiln. The greenish tint which, from time to time, occurs in the china trade in the body of the bisque ware is usually due to shortage of fluxes in the body. It follows that this shortage may be caused by: (1) Excess of alumina in the mixture, brought about by change of china clays where the density of the new clay is different from the density of the old; (2) the inadvertent omission of stone from the mixture or the substitution of a cheaper white stone for mild purple or hard purple. It may also be caused by the employment of inferior bone, having low phosphate content. The bulk of the trouble in "pinholed" china is caused by insufficient grinding of materials. Brown china or "Rinderpest" is the brown coloration found in the body of the ware when it comes from the kiln. Bernard Moore found the lack of flux in the body to be responsible for this trouble. Various ideals in the pottery trade are discussed. E.J.V.

Physical properties of semivitreous bodies. ANON. *Pottery Gaz.*, **52** [606], 1952 (1927).—Some of the more important conclusions arrived at as a result of an American investigation into the physical properties of semivitreous white ware for domestic table use are: (1) American earthenware bodies differ more than is generally realized in regard to their maturing temperature (which corresponds to firing to an absorption of about 8%). Some mature fully at cone 7, others at cone 9. (2) There are 2 periods of firing during which the absorption of the body is materially decreased, one between cones 4 and 5 because of the pressure of English ball clay, and one between cones 6 and 8 because of feldspar. (3) The desired maturity of a body can be obtained by firing at a

lower temperature (cone 6, for example), and then holding at this temperature until cone 8 is down. E.J.V.

Lead poisoning prevention. ANON. *Chem. and Ind.*, **46,** 1186(1927).—The new Industrial Museum in London contains a section devoted to industrial disease; included in it are photographs showing methods for the prevention of lead poisoning and silicosis. H.H.S.

Fritted glaze. TAKEO OSHIDA. *Jour. Jap. Ceram. Assn.*, **34** [400], 173–82(1926).—A general discussion on fritted glazes for earthenware is given followed by the description of his own experiments. S.K.

Ivory porcelain of Tobe. SHINICHI TERAUCHI. *Jour. Jap. Ceram. Assn.* **35,** [409], 9–11(1927).—The ivory ware of Tobe in the Province of Iyo was originated by late Wahei Mukai who discovered an ivory firing clay at Karasunosu in 1890. At present the wares are manufactured by applying a glaze composed of Takanogawa rock 75, and ash of inferior woods 25, on bodies made of Mannen clay 80, and Takanogawa clay 20. T. derived a better result with a glaze composed of Takanogawa rock 50, ash of Quercus Glandulifera 30, and feldspar 20. They are fired to cone 10 with neutral flame. S.K.

Microstructure of porcelain insulator. RYOICHI SHIGEMUNE. *Tokio Industrial Lab., Rept.*, **22** [5], 44 pp. (1927).—Descriptions and discussions are given on the microstructures of 30 insulators, 4 spark-plugs, and 1 porcelain for electric boiler with 24 photographs. (*1*) *Porosity.* The largest pores in each of the samples including low-voltage goods are smaller than those in ordinary porcelain ware and are round or oval indicating that they have been produced by overfiring. The other pores originate also chiefly from the same cause. Porosity and size of pore are generally small in the extra high-tension insulators. Most of the foreign products have smaller porosities and larger pores than the Japanese. The spark-plugs show a wide range of porosity. (*2*) *Comparison of quartz-grains.* Foreign porcelains contain far larger and more numerous quartz-grains than the Japanese. In the latter, quartz is not used as a raw material and comes from the ground-mass of liparites which contains fine quartz grains, and therefore only a part of them remains undissolved. (*3*) *Comparison of feldspar grains.* The electric insulators contain more feldspar than the usual porcelain. Most of the feldspar grains show fibrous structure due to the mullite formation. (*4*) *Fibrous structure.* The fibrous structure is found in groups, as it owes chiefly to the transformation of feldspar. The groups with rectangular or other outlines of original feldspar grains are especially rich in the foreign products. In the Japanese porcelains, they have generally indefinite shapes and vague outlines. The fibrous structure is developed better in porcelains fired to comparatively high temperatures. (*5*) *American porcelains.* Indications are that most of the American factories use same bodies for extra high-tension insulators of different types with a few exceptions. S.K.

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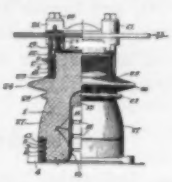
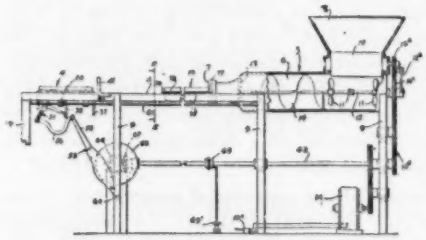
Suspension insulator. JOHN M. PECK. U. S. 1,653,117, Dec. 20, 1927. A suspension insulator comprising a hollow unit of insulating material, a bolt member having a cylindrical body and an enlarged end portion having a flat base and a shoulder on its underside at approximately 45° to the longitudinal axis of the bolt member, and a one-piece integral thimble surrounding the body and enlarged end portion of the bolt member, the thimble having a flat end parallel to and slightly spaced from the base of the bolt member, the flat end being spaced from the insulator body and the space being filled with a layer of resilient cement, the thimble having a constricted portion surrounding the body of the bolt member, the shoulder on the bolt member being in contact with and sup-

ported by the constricted portion, the thimble further having a flared portion diverging from the body of the bolt member in a direction away from the enlarged end, the flared portion terminating in a corrugated portion spaced a substantial distance from and entirely free from the body of the bolt member, the thimble being positioned within a cavity in the insulator body, and cement filling the space between the side walls of the cavity and the sides of the thimble having a seamless and unbroken periphery to prevent seepage of cement to the interior of the thimble.

Insulator. HORACE P. LIVERSIDGE. U. S. 1,653,436, Dec. 20, 1927. (1) A porcelain insulator in combination with a band of soft metal shrunk upon it tightly gripping its periphery at one end and having an exposed outer surface finished for attachment of supporting parts. (2) A porcelain insulator having its outer surface roughened at an end and its adjoining surface smooth in combination with a band of low fusing-point metal tightly engaging the roughened portion and a support for the insulator surrounding the band.

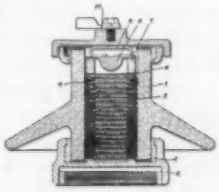


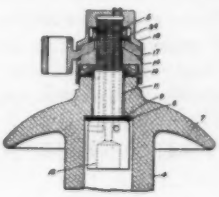
Method of insulator manufacture. HORACE P. LIVERSIDGE. U. S. 1,653,437, Dec. 20, 1927. The steps in the method of uniting an exterior connection with an insulator, which consist in die casting a band of soft metal about the circumference of the insulator and in removing the exterior mold from about the ring, thereby freeing the exterior of the ring for attachment of the exterior connection.



Apparatus for making tile and other plastic products. JOHN R. AND GERONIMO TERRES. U. S. 1,654,669, Jan. 3, 1928. In a tile making machine, a tray, and means to hinge it for swinging movement, the means including spaced hinged members, trunnions mounted in them and projections on the tray fitting the trunnions.

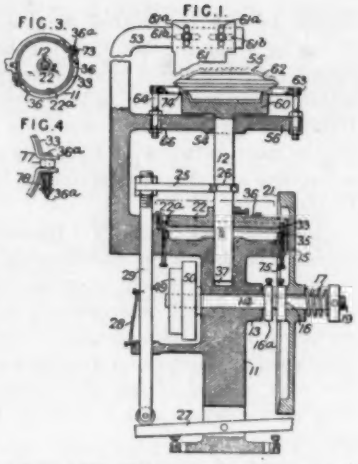
Lightning arrester. SOLOMON M. PINELES. U. S. 1,655,972, Jan. 10, 1928. A glow-discharge lightning arrester comprising closely spaced resistor disks severally composed of an inert body member and a finely divided conductor distributed throughout the body member, the spacing between the disks being 3 mm., the resistivity of the disks being of the order necessary to cause the discharges to take the form of a glow characterized by a voltage of the order of 300 volts per gap, the discharge surfaces being coated with a non-conducting film which is thin relative to the spacing between disks and which is sufficiently porous to permit glow discharges to occur without puncturing the film.





Terminal. ATLEE B. SAURMAN. U. S. 1,656,395, Jan. 17, 1928. In a terminal, lead-out structure, including a sleeve of insulating material and a stem of conducting material secured in place in the bore of the sleeve, the outer end of the stem being screw-threaded, and three nuts and an aerial-joining collar adapted to be applied successively to the stem, one nut underlying and the two

others overlying the collar, the collar engaging the underlying nut and both of the overlying nuts engaging the collar over complementary conical surfaces.



Pottery-shaping. W. J. MILLER. Brit. 279,503, Dec. 21, 1927. Pottery-shaping mechanism comprises a supporting member (63) recessed to receive a mold (62) carried by a reciprocable and rotatable chuck (60) and means are provided to lift the chuck and raise the mold from its supporting member so that the material (55) may be shaped by a profile.

Equipment and Apparatus

Industrial filtration and filter aids. ANON. *Chem. and Ind.*, **46**, 1144–47 (1927).—Filters are grouped into 3 classes: (1) those having loose filtering layers such as sand or paper-pulp, (2) those having woven or matted layers of wool, cotton, asbestos, or other fibers; (3) those with rigid layers such as stoneware or molded porous plates. The rate of flow in the filter is directly proportional to the differential pressure, and inversely as the thickness of the cake, but there are other constants which must be found by practice before a formula can be derived. Solids found in filtration are either rigid or, like gummy and colloidal matter, non-rigid and susceptible to distortion and other changes. Aids to filtration therefore have to do with changing the physical characteristics of the solid or liquid by introducing other solids, or by other means, such as raising temperature to reduce viscosity. The rest of the paper is devoted to a description of Super-cel, which is prepared from the mineral celite, as a filter aid. H.H.S.

Apparatus for measuring weight and volume of the contents of receptacles. PARKER, JACKMAN, AND VOWLER. *Chem. and Ind.*, **46**, 1181–82 (1927).—A pressure cell formed of a metal casing provided with a thick rubber diaphragm and filled with glycerin was adopted. One or more of these cells are placed under the feet at one end of the receptacle to be tested, and are connected to a gage graduated to read weights, the fluid employed to transmit pressure from cell to gage being glycerin. The feet of the other end of the receptacle rest on knife edges, and provision is made for adjusting the pull exercised by the belts driving the machine. H.H.S.

Crushing and grinding: I. Surface measurement of quartz particles. JOHN GROSS AND S. R. ZIMMERLEY. *Min. and Met.*, **9** [253], 28 (1928).—The long controversy between the adherents of Kick and Rittinger evidence the need for fundamental data on crushing, especially an accurate means of determining the amount of surface produced by crushing. After discussing various methods, one which depends on the rate of dissolution of quartz in HF is taken up in detail; the various conditions affecting the accuracy of the test were investigated, indicating that the results were accurate within 5% of the true value. Results on 3 different kinds of quartz indicate that there are no perceptible variations by varieties, but the method is not a true measure of surface as the rate of dissolution is not equal in all directions in the crystal solid. By silver-coating the quartz a calibration figure was obtained by which the relative surface figure may be converted to an absolute surface. F.P.H.

New machinery developments during 1927. ANON. *Rock Prod.*, **30** [26], 171–87

(1927).—A description of the improvements that have taken place in the following types of mechanical devices during 1927 is given: (1) drilling and blasting, (2) excavating and material handling, (3) transportation equipment, (4) crushers and pulverizers, (5) special steels and alloys, (6) conveyers and elevators, (7) screens and washers, (8) cement mill equipment, (9) speed reducers, (10) prime movers, (11) electrical equipment, (12) lime kiln and hydrators, (13) dust collectors, (14) air separators.

F.P.H.

Electrical and thermal properties of metals. GRUENEISEN AND GOENS. *Zeit. f. Physik*, **44,** 615 (1927); *Min. and Met.*, **9** [253], 25–26 (1928).—Electrical and thermal properties of Au, Pt, Cu, W, Rh, Al, and Fe in single and polycrystalline condition are reported. The thermal resistance of good conductors is increasingly affected by impurities as the temperature falls, but grain size was not found positively to have an effect. In a metal, the thermal resistance is a linear function of the electrical resistance, but this linearity no longer holds with large amounts of impurities, especially at low temperatures. The resistance is composed of a metallic and a nonmetallic part. The metallic component fulfills the Wiedemann-Franz-Lorenz law for cubic metals independently of the purity or strain. The non-metallic part of the thermal resistance is also independent of the purity and strain but varies with the temperature. The theoretical aspects of these results are also discussed and will be of great interest to those who are applying themselves to the scientific side of metallography. F.P.H.

Standard methods of verification of testing machines. *A.S.T.M. Stand.*, (Series E4–27.) Pp. 921–31 (1927).—Definitions are given for (*a*) testing machine; (*b*) error; (*c*) percentage of error; (*d*) correction; (*e*) tolerance; (*f*) loading range. Methods for verifying testing machines that measure load by (*a*) standard weights, (*b*) standardized proving levers, (*c*) means of an elastic calibration device, and (*d*) comparison method, are described. Tolerances for testing machines that measure load are as follows: new machines ±1.0%, used machines ±1.5%. R.A.H.

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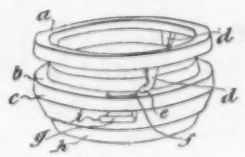
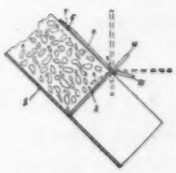
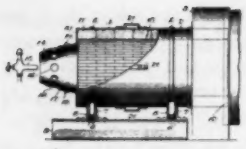
Locking means for pottery molds. ERNEST EDWARDS. U. S. 1,653,396, Dec. 20, 1927. A mold construction including separable upper and lower sections, the upper section being provided with openings and the lower section being provided with bayonet sockets registering with the openings, and a locking ring having depending locking members provided with laterally offset feet adapted to enter the openings and upon movement relative to the sections interlock with the bayonet sockets to hold the sections against separation.





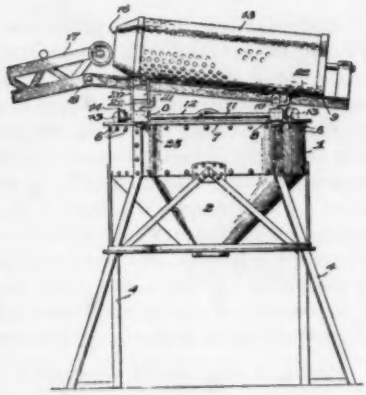
Trip gate for chutes. PAUL C. GRAHAM. U. S. 1,654,043, Dec. 27, 1927. A trip gate for chutes, etc., comprising a pivotally mounted gate, a trip arm on the gate, and trip means adapted to engage the arm to hold the gate in closed position, the trip means being also adapted to hold the gate in open position, and paddle extending at an angle from the gate, and being adapted to engage the stream of material to assist in rotating the gate.

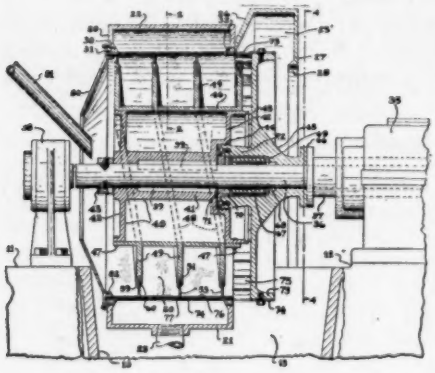
Combustion chamber. HORACE W. ASH AND WILLIAM B. SLEMMER. U. S. 1,654,358, Dec. 27, 1927. The combination with a rotary drier, of an independently rotatable tubular combustion chamber arranged at one end of the drier and having its



axis substantially parallel with the axis of the drier, means for injecting gaseous fuel into the outer end of the combustion chamber, and circumferentially placed equi-distant handles secured externally of the combustion chamber for facilitating the periodic rotation of the latter to insure uniform action of the flame on the entire internal area of the combustion chamber.

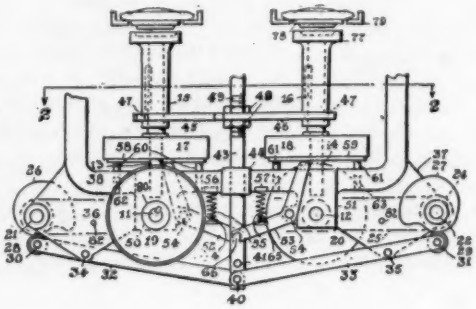
Conveyer and sifting-screen apparatus. FRITHJOF N. KOLBERG. U. S. 1,654,590, Jan. 3, 1928. In combination with a hopper, a ringlike turn-table, secured to the top of the hopper with its open center in register with the hopper interior, a carriage composed of transverse bars and a pair of crossed shafts having flanged rollers journaled on their ends mounted on the turn-table and secured to the bars, a frame disposed at an incline above the carriage, a sifter screen on the frame having a conveyer connected to its inlet, means to secure the frame to the bars, and means to latch the carriage to the turn-table.





Centrifugal machine. WILLIAM C. LAUGHLIN. U. S. 1,655,426, Jan. 10, 1928. A centrifugal machine comprising a rotatable drum having a filtering screen, a distributor within the drum having a spiral flange and blades loosely mounted upon the periphery of the flange and controlled entirely by centrifugal force, the blades being in continuous contact with a surface of the screen.

Mechanism for producing intermittent rotation of jigger spindles. WILLIAM J. MILLER. U. S. 1,655,431, Jan. 10, 1928. In a mechanism for producing intermittent rotation of a jigger spindle a continuous motion vertical friction gear, a horizontally disposed friction gear, in intermittent contact therewith, a means for alternately raising the horizontal gear out of contact with the vertical gear and lowering it into contact therewith; and a means for transmitting rotation from the horizontal gear to the spindle, thereby intermittently rotating the latter.



Classifier. ALBERT H. STEBBINS. U. S. 1,655,574, Jan. 10, 1928. A classifier comprising in combination, an elongated casing supported in an upright position and constructed to form a treatment chamber, means for delivering the materials to be treated to the upper end of the chamber to pass downwardly therein, a blast conduit having discharge openings at spaced points lengthwise of the casing and formed to direct jets of air across the chamber, downwardly sloping plates mounted in the casing to divide the chamber into settling compartments disposed one above the other and the plater being arranged to direct the materials that settle in each compartment into the path of the next air jet, and means for exhausting air from the different compartments.

Classifier. ALBERT H. STEBBINS. U. S. 1,655,575, Jan. 10, 1928. A classifier, comprising in combination, an upright casing constructed to provide a treatment chamber, means for delivering the materials to be treated into the upper portion of the chamber to move downwardly therein under the force of gravity, a series of downwardly inclined plates mounted in the chamber to receive the falling materials, means adjacent the lower end of each inclined plate for directing a blast of air upward across the path of the materials sliding along the respective plates to carry the lighter particles upward away from the plate that delivers the materials to a particular air blast and means for removing from the chamber the lighter particles that remain suspended in the air.

Classifier. ALBERT H. STEBBINS. U. S. 1,655,576, Jan. 10, 1928. A classifier comprising in combination, an upright casing, means for delivering the materials to be treated to the upper portion of the casing to pass downward within the central portion of the casing, frusto-conical partitions supported one above the other about the central axis of the casing to form downwardly inclined settling chambers between them and the partitions being constructed to direct the particles sliding down their inclined walls toward the central axis, means for producing air jets within the casing for blowing the falling materials outwardly into the settling chambers, and means for removing from the settling chambers, the lighter particles that remain suspended in the air.

Classifier. ALBERT H. STEBBINS. U. S. 1,655,577, Jan. 10, 1928. A classifier comprising in combination, an upright casing, means for delivering the materials to be treated to the upper portion of the casing to pass downwardly therein under the influence of gravity, air blast nozzles provided along the opposite sides of the casing and adapted to direct air currents across the casing from one wall to adjacent the other wall so that they will intersect the path of the materials moving downwardly within the casing from its opposite sides, and means for removing from the casing the lighter particles that remain suspended in the air.

Kilns, Furnaces, Fuels, and Combustion

Electrical kilns in pottery firing. ANON. *Brit. Clayworker*, **36** [428], 261 (1927).—Abstract of paper by B. Moore and Major Campbell given at the recent meeting of The Ceramic Society discusses the use of electricity in the firing of china. R.A.H.

U. S. government master specification for lubricants and liquid fuels and methods for sampling and testing. ANON. Bur. Mines, *Tech. Paper*, No. 323B (1927). R.A.H.

Electric muffle kilns introduced to the Nagoya district. KOTARO ASUKAI. *Jour. Jap. Ceram. Assn.*, **34** [407], 499–504 (1926).—General descriptions on electric kilns for overglaze colors now prevailing in the Nagoya district are given, particular attention being given to their working cost compared with old wood-fired kilns. S.K.

Kinks that save dollars. ANON. *Ceram. Ind.*, **10** [1], 48–49 (1928).—A description of several features of the Michigan Enameling Works at Kalamazoo, Mich. It has profitably revamped its sandblast and spray booths, thus speeding up production. The

plant smelts 750 lbs. of enamel in from 1 to 1¼ hours at total cost of 6 to 8 cents per lb. A smelter is used and gives satisfactory service for over 300 smelts without relining at 2200°F. F.P.H.

Computer for evaluating coals. ANON. *Min. and Met.*, 9 [253], 47 (1928).—The fuel value computer, recently put on the market by the Coal Specialties Co., New York, is an ingenious instrument for evaluating coals on the basis of facts, and of use to the buyer and seller alike. It is a so-called circular slide rule with 4 scales, as follows: (*a*) delivered fuel cost-dollars per net ton as received, (*b*) per cent ash in coal (as received), (*c*) B.t.u. per lb. of coal (as received), (*d*) fuel cost in cents per million (recoverable) B.t.u. The operation and use of the slide rule is described. F.P.H.

Working time of brick makers (burners) on kilns equipped with stokers. ANON. *Tonind. Ztg.*, **51** [74], 1352–53 (1927). F.P.H.

Use of fuels in brick kilns. W. E. RICE. *Clay Worker*, **88** [5], 370–76; [6], 442–45 (1927).—The three stages of firing, (watersmoking, oxidation, and soaking periods) and the cooling period are described as are the limitations imposed upon the fuel or combustion engineer. Kilns are classified according to methods of firing, as follows: (1) those in which the relative position of the fires and ware is stationary and firing is periodic and following the cycle of watersmoking, heating and soaking, with or without utilization of stored heat (illustrated by all periodic kilns); (2) those in which the ware is stationary and the position of the fires movable (illustrated by the progressing-fire tunnel kiln (Hoffman type)) and the continuous compartment kiln; (3) those in which the fires are stationary and the ware movable, as in the railroad car-tunnel kiln. Under periodic kilns R. describes and discusses the clamp kiln, closed kiln, round kilns, and rectangular kilns. Furnaces and firing methods in periodic kilns are taken up. The influence of coal burned on type of furnace in periodic kilns is taken up with subtopics of combustion of coal, heating of fresh coal, and firing with gas or oil. The function of the bag wall in periodic kilns is described. Course of the kiln gases, importance of floor openings and flues, chimneys, effect of heated gases, and kiln proportions are other subjects discussed in connection with periodic kilns. Under the general classification of regenerative kilns are taken up the following: Hoffman kiln, modification of the Hoffman kiln, the continuous chamber type, the railroad car-tunnel type, the direct-fired type, and the muffle-type railroad car-tunnel kiln. Characteristics of the various fuels, including bituminous coal, anthracite and coke, fuel oil, natural gas, wood, producer gas, and lignite, used in kilns are listed. E.J.V.

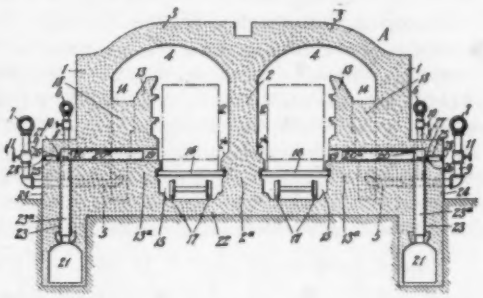
New method of firing china biscuit. ANON. *Pottery Gaz.*, **52** [606], 1928–29 (1927).—A description of the "C.P.B." type of kiln designed by 3 men, the initials of whose surnames are linked in the name of the kiln. It was worked out to provide a means of so altering the firing of china biscuit as to render possible a serious reduction of the amount of placing material, thereby lightening the work of the placer, and in direct proportion shortening the time of firing. The kiln is of the intermittent type, smaller in height and girth than the average china biscuit kiln, coal-fired, and the heat enters in small volume through square apertures in the floor, measuring about 8 x 8 in., and is drawn through the bungs of ware, placed in saggers, to a central fireclay tube which runs from the floor of the kiln to the crown. This central tube is copiously perforated, and by means of these holes the heat is drawn laterally through the saggers, an important point in regard to the uniform circulation of heat in a kiln. Even distribution of heat and more equal contraction of the ware is claimed as a result of 4 mouths in the kiln instead of the usual 9. Several other features are mentioned. E.J.V.

Steel melted by radio. C. H. DESCH. *Morning Post*, Dec. 7, 1927.—Sheffield is now provided with the first high-frequency electrical furnace operated by "wireless." It is installed at the Edgar Allen and Co. plant. The process is embodied in an Ajax-

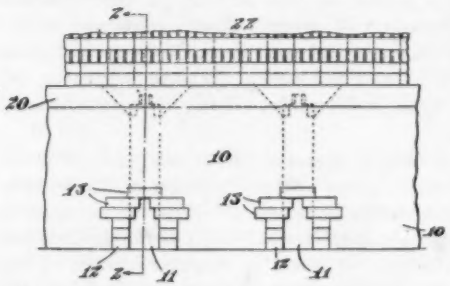
Northrop high-frequency crucible furnace. Between the container and its wooden covering is a water-cooled coil from which electric heat is conveyed by wireless to the metal charge by induction. The metal so made is extraordinarily free from contamination by S and P and foreign gases. Furnace costs are claimed to be reduced 1/3 to 1/2 by this method. H.H.S.

PATENTS

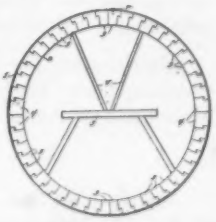
Tunnel kiln. WILLIAM LEE HANLEY, Jr. U. S. 1,653,174, Dec. 20, 1927. A tunnel kiln having a firing zone located substantially centrally of the length of the kiln, and provided with a longitudinal goods space and direct firing means discharging their products of combustion into the upper portion of the goods space, the goods space being provided at separate points longitudinally and adjacent to its lower portion, with eduction ports, eduction passages connected therewith, and horizontaliy disposed exterior passages extending in alignment with portions of the eduction ports to the exterior of the kiln to permit the goods in the lower portion of the goods space of the firing zone to be viewed from the exterior of the kiln.



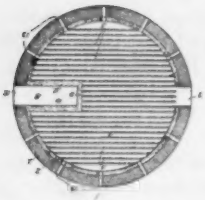
Kiln bottom. CLAUDE E. FULLER. U. S. 1,654,481, Dec. 27, 1927. An improved kiln bottom comprising a pair of walls spaced apart from each other the width of the kiln and extending throughout the length of the kiln, permanent fire boxes arranged at intervals along each of the walls and opposite corresponding fire boxes of the other wall, a sealing ledge or rabbet on the front upper surface of each wall, temporary filling comprising units of brick to be fired located and filling the space between the walls, and the unit of brick being arranged with opposite faces aligned with the fire boxes.



Tile lining for cylindrical kilns. GEORGE P. REINTJES. U. S. 1,655,566, Jan. 10, 1928. A tile lining for kilns, combining set of key tiles having edges in wedge relation and their opposite edges stepped, and intermediate tiles having their opposite edges stepped and interlocking relation with each other and the stepped edges of the key tiles.



Method of and apparatus for heating clay products in kilns or ovens. CHARLES H. CAMP. U. S. 1,656, 67, Jan. 17, 1928. The improvement in kilns and the like, which comprises means for supplying hot combustion gases thereto and means for distributing the hot gases in the kiln, including means for withdrawing a portion of the gases from a zone remote from the source of such gases and out of the normal direct path of the gases through the kiln and means for returning the gases to the kiln at the source of the gases.



Kiln. HENRY G. LYKKEN. U. S. 1,656,642, Jan. 17, 1928. A kiln comprising a floor upon which the ware to be fired is placed, side walls and a roof, means for supplying products of combustion under pressure to the ware, side walls having closable openings located therein above the floor for permitting controllable escape of gases to the atmosphere.

Geology

Geologists to study glass flashes. ANON. *Nat. Glass Budget*, **43** [35], 26 (1927).—Science is attempting to solve the mysteries of Glass Mountain in Modoc National Forest in California. Authorities on the reservation will procure the services of geologists to study the peak in order to determine the reason for the flashes of light shooting up from its sides from time to time. The sides of the mass appear as a molten crystal. The huge vent has accumulated a mound of glistening obsidian, which is thought to be the terminus of an extinct volcano. During the winter the area is snowbound, but the summit of the peak, half an acre in extent, remains black, free from snow. The name, Glass Mountain, has been given because of the obsidian filling its crevice. P.F.C.

Mineral resources of the U. S. in 1926. F. J. KATZ AND M. B. CLARK. Published by the Bur. Mines, 1927.—This report is the 9th annual preliminary summary of U. S. mineral production. This statistical summary of the quantity and value of mineral products for the calendar year 1926, comparing preceding years and with supplemental data on imports and exports, helps to gage the size and growth of the mineral industries. R.A.H.

Ceramic and glass raw material of Bavaria. M. PRIEHÄUSSER. *Keramos*, **6** [10], 381–82 (1927).—Raw materials found in Bavaria and used in the ceramic and glass industries are summarized as follows: (1) feldspar and kaolin, (2) clay, (3) quartz, (4) calcium salts such as the carbonate, sulphate, and fluoride, (5) talc, (6) graphite. F.P.H.

British Guiana bauxite deposits. LLOYD T. EMORY. *Min. and Met.*, **9** [253], 8–11 (1928).—A description of the country is given and the location of the bauxite deposits is shown on maps. There are 3 classes of deposits. Those of commercial importance occur in a sand-clay belt and are characterized by remarkable chemical uniformity. The chief deposits are in the form of lenses or irregular masses. They vary from a few feet to 30 ft. in thickness. The lenses occur between clay beds and the overlying sands. F.P.H.

Phosphate rock at Nauru and Ocean islands. ANON. *Chem. and Ind.*, **46**, 1188 (1927).—In reply to a question in Parliament, the Prime Minister said that numerous borings had been made on these two islands, and it was estimated that together they contain over 100,000,000 T. of phosphate of quality 85–88% $Ca_3(PO_4)_2$. H.H.S.

Molybdenum development in Canada. ANON. *Chem. and Ind.*, **46**, 1153 (1927).—Arrangements are being made to develop the large deposit of molybdenite at Lake Malartic, near Amos, Quebec. H.H.S.

BOOK

Amérique du Sud. PIERRE DENIS. Paris: Librairie Armand Colin, 1927. Price 50 fr. The 15th volume of the "Geographie Universelle," beautifully printed, with excellent maps and photographs, treats of the geological structure, climate, etc., of South America. H.H.S.

Chemistry and Physics

Electroendosmosis of aqueous solutions through a diaphragm of sintered glass powder. F. FAIRBROTHER AND H. VARLEY. *Jour. Chem. Soc.* (London), 1584–89 (1927); *Sci. Abs.*, **30**, 837 (1927).—Experiments with a diaphragm of sintered Jena Geräte glass powder in H_2O and HCl solutions of varying concentrations show that electroendosmosis decreases after a time and in 0.01 NHCl becomes reversed in direction. The permeability to H_2O also decreases with the time the H_2O is passed through.

D.E.S.

Determination of the thermal changes occurring in $\alpha \rightleftarrows \beta$ transformation of quartzite. YOSHIAKI TADOKORO. *Jour. Jap. Ceram. Assn.*, **34** [397], 1–23 (1926).—The transformation of α quartz to β at 575°C is an instance of allotropic modifications, being a change from hexagonal trapezohedral tetrahedron to same hemihedron. The heat evolved or absorbed by quartz in the transformation of α and β modifications at 575° has been determined by a special apparatus. (I) *Apparatus for thermal analysis and procedure of the experiment.* The apparatus consists of four parts: (1) A vertical electric resistance tube furnace, 1 m. long and 60–85 mm. wide, in which the coil is wound in such a way that the temperature in the furnace is highest at the middle point and descends straight to both ends. (2) An alundum crucible with two compartments for sample and neutral body or alundum, suspended by a refractory tube. A noble metal thermocouple and a difference couple of nichrome and advance wires pass through the tube. (3) A millivoltmeter, potentiometer, galvanometer, lamp, and scale. (4) A mechanism to move the crucible and tube up and down in the furnace. They are moved with a velocity of 3 mm. per minute. The required range of the motion is about 100°C up and below the transition point. (II) *Calculation.* The heat flowing into the sample $= K \cdot \Delta T_f \cdot \text{time} \cdot A$, or true specific heat $\cdot \Delta T_s \cdot$ time $\cdot m$; where m = weight of sample; ΔT_f = temperature gradient in the furnace; ΔT_s = temperature rise in sample per unit time when no transformation occurs; K = thermal conductivity; and A = surface area. Then $K = \dfrac{\text{specific heat} \cdot m}{A}$, since $\Delta T_f \fallingdotseq \Delta T_s$. Now the heat flowing into the sample at a time S per unit time per gram is true specific heat $\cdot \Delta T_s$. The heat utilized for temperature rise per minute when transformation is going on is $(\text{true specific heat})_o \cdot \Delta T_{so}$; where ΔT_{so} and $(\text{specific heat})_o$ are temperature rise per minute and specific heat, respectively, during the transformation. Then the heat absorbed as latent per minute in the transformation is: (true specific heat) $\cdot \Delta T_s -$ (true specific heat)$_o \cdot \Delta T_{so}$. Hence total latent heat q_1 flowing into the sample along the axis of the furnace is:

$$q_1 = \sum_{S_1}^{S_2} [(\text{specific heat}) \cdot \Delta T_s - (\text{specific heat})_o \cdot \Delta T_{so}]$$

where S_1 and S_2 denote the beginning and the end of the transformation respectively. It has been ascertained by experiment that $K/K_o \fallingdotseq (T_f - T_s)_o/(T_f - T_s) = (\text{specific heat})/(\text{specific heat})_o$; where K_o = thermal conductivity in the inversion, $(T_f - T_s) =$ difference in temperature between the furnace and the sample before the inversion and $(T_f - T_s)_o =$ same after the inversion. Hence

$$q_1 = \sum_{S_1}^{S_2} \left\{ (\text{specific heat}) \cdot \Delta T_s - (\text{specific heat}) \cdot \frac{(T_f - T_s)}{(T_f - T_s)_o} \cdot \Delta T_{so} \right\}$$

$$= (\text{specific heat}) \sum_{S_1}^{S_2} \left\{ \Delta T_s - \frac{(T_f - T_s)}{(T_f - T_s)_o} \cdot \Delta T_{so} \right\}.$$

As ΔT_s is constant, we have:

$$q_1 = (\text{specific heat}) \cdot \left\{ \Delta T_s (S_2 - S_1) - \sum_{S_1}^{S_2} \frac{(T_f - T_s)}{(T_f - T_s)_o} \cdot \Delta T_{so} \right\}$$

$$= (\text{specific heat}) \cdot \left\{ \Delta T_s (S_2 - S_1) - \frac{(T_f - T_s)}{(T_f - T_s)_o} \cdot \sum_{S_1}^{S_2} \Delta T_{so} \right\}.$$

When the inversion begins, a lateral temperature gradient occurs between the sample and surrounding air due to the latent heat absorbed by it. The lateral flow of heat takes place only while the transformation is continued and is entirely utilized as latent heat. Its amount per min. at a given time S in the inversion can be expressed as follows:

$$(\text{specific heat})_o \cdot \text{constant } (T_s - T_{so}) \cdot m = (\text{specific heat}) \cdot \frac{(T_f - T_s)}{(T_f - T_s)_o} \cdot \text{constant } (T_s - T_{so}) \cdot m$$

where T_{so} denotes the temperature of the sample at time S. Then the total heat in the inversion from S_1 to S_2 per g. is:

$$q_2 = (\text{specific heat}) \cdot \frac{(T_f - T_s)}{(T_f - T_s)_o} \cdot \text{constant} \sum_{S_1}^{S_2} (T_s - T_{so}).$$

Hence the total quantity of heat that flows to the sample in the inversion is:

$$q_1 + q_2 = \text{specific heat} \cdot \left[\Delta T_s (S_2 - S_1) + \frac{(T_f - T_s)}{(T_f - T_s)_o} \cdot \left\{ \text{constant} \sum_{S_1}^{S_2} (T_s - T_{so}) - \sum_{S_1}^{S_2} \Delta T_{so} \right\} \right] \cdot$$

As $\dfrac{(T_f - T_s)}{(T_f - T_s)_o} \fallingdotseq 1$, $q_1 + q_2 = \text{specific heat} \cdot [\text{constant } \sum (T_s - T_{so}) + \sum \Delta T_s - \sum \Delta T_{so}]$.

Putting M_o for $\sum \Delta T_s - \sum \Delta T_{so}$, we have $q_1 + q_2 = \text{specific heat } [\text{constant } \sum (T_s - T_{so}) + M_o] \cdots (a)$. (III) *Structure of Quartzites.* Chemical analysis and microstructure of several quartzites used in the iron works are given. (IV) *Experiments.* Table I is some of the results obtained with various quartzites.

TABLE I. TRANSFORMATION HEAT OF QUARTZITES

(Velocity of sample = 3 mm. per min. Constant = 0.55. Specific heat = 0.22–0.30)

Locality	Chemical composition			Transformation on heating			Transformation on cooling		
	SiO_2	Al_2O_3	Fe_2O_3	Begins at	Ends at	Heat absorbed cal./g.	Begins at	Ends at	Heat evolved cal./g.
No. 1 Usuki	92.04	0.66	1.86	540°C	604°C	0.525–0.716	629°C	584°C	0.560–0.860
No. 2 "	92.48	2.20	3.02	561	595	0.409–0.558	624	577	0.427–0.582
Sonobe	94.70	1.27	2.23	550	594	0.342–0.457	627	589	0.369–0.500
Ichijima	94.22	0.97	2.48	552	580	0.333–0.454	620	597	0.341–0.465
Dairen	96.88	1.34	0.66	558	593	0.391–0.533	611	583	0.427–0.582

Conclusions: (*a*) the transformation is reversible, being endothermic on heating and exothermic on cooling; (*b*) the heat is very small, amounting to from 0.4 to 0.8 cal. per g.; (*c*) the transformation heat on heating is smaller than that on cooling; its cause is discussed; (*d*) quartzites with smaller transformation heat are excellent material for silica refractories; (*e*) in the Ichijima quartzite with small heat change ferric oxide is contained as solid solution and structure is cryptocrystalline, whereas the oxide in those with larger heat changes is scattered as grains in quartz grains. (V) *Specific gravity.* The relation between the inversion heat and specific gravity of the quartzites is described. (VI) *Specific heat method of determining the transformation heat.* The result obtained by the usual method of determining the transformation heat is compared with that described above. The specific heat method is very unreliable. (VII) *Thermal expansion of the quartzites at 575°C.* The linear expansion which occurs at 575° and amounts to about 0.5% is more gradual and smaller in quartzites with small transformation heat than those absorbing much more heat. S.K.

Thermal changes and dehydration phenomena of some hydrous minerals. SHUKUSUKE KOZU AND MINEICHI MASUDA. Tohoku Imperial University, *Sci. Reports*, Series III, **3** [1], 33–68 (1926).—Thermal analyses of Sawatari kaolin, kaolin of Takatama mine, and English china clay are reported. On heating these kaolins thermal changes take place in 4 different regions of temperature between 20 and 1300°C excluding the change due to evaporation of absorbed water at temperatures lower than 200°C. Of these changes, 2 are the heat absorption, commencing at about 400° and at a temperature between 600 and 650° respectively, and the other 2 the heat evolution, commencing at about 1000° and at a temperature between 1130 and 1250°. Recently G. Tamman and W. Pape have concluded that kaolin dissociates into alumina and silica after dehydration at 550°C and that the dissociated alumina takes another form at 950°C. However, the heat evolution, appearing between about 400 and 700°, can be clearly divided into 2 at a temperature between 600 and 650°. The part representing the lower temperature evidently indicates the heat absorption which is due to the expulsion of H_2O, and that representing the higher temperature the heat absorption, which is due to the dissociation of the dehydrated mineral into different components. According to S. Saiki of the Institute, the refractive index of the meta-kaolin is much lower than that of any form of free alumina and he has drawn the conclusion that the meta-kaolin is possibly a mixture of silica set free and aluminium silicates. The heat evolution appearing between 1130 and 1250° may be ascribed to the beginning of the formation of a compound, whose refractive index lies between 1.55 and 1.56, the figures determined for kaolin fired at 1300 and 1400° respectively for one hour. The refractive index is much lower than that of mullite, but the material must be an intimate mixture of silica and mullite, or an unstable form of mullite. Refractive index of Atsushio kaolin, as measured by S. Saiki, heated at different temperatures for 1 hr., has been measured by immersion method (Table I).

TABLE I

Refractive Index of Atsushio Kaolin, Heated at Different Temperatures

Temp. in °C	0	405	558	608	700	1104	1200	1300	1400
Min. refractive index	1.550	1.561	1.515	1.460	1.460	1.460	1.495	1.548	1.550
Max. refractive index	1.592	1.567	1.545	1.535	1.530	1.530	1.547	1.555	1.555

The dissociated materials composing the meta-kaolin, heated at temperatures between 600 and 900°, are characterized by refractive indices which fall within the limits of 1.47 and 1.53. The minimum value corresponds practically to that of the fused silica, and the maximum is much lower than that of alumina. The thermal curves of Heulandite from the Bonin Islands, apophyllite, diaspore, talc, alunite, gypsum, sericite, and muscovite are given and discussed. S.K.

Standard methods of chemical analysis of zinc chloride. *A.S.T.M. Stand.*, (Series D199–27) pp. 693–96 (1927).—These methods cover the determination of the percentages of insoluble basic zinc chloride, zinc chloride, and iron present in commercial concentrated solutions of zinc chloride or in fused or granulated zinc chloride, for use in the preservative treatment of wood. R.A.H.

Standard definitions of terms relating to specific gravity. *A.S.T.M. Stand.*, (Series E12–27) pp. 932–34 (1927).—Definitions are given of (1) absolute specific gravity (of solids and liquids). (2) Specific gravity (of solids and liquids). (3) Apparent specific gravity (of solids). (4) Bulk specific gravity (of solids). R.A.H.

Automatic analysis of liquids. H. S. HATFIELD. *Chem. and Ind.*, **46**, 1149 (1927).—Liquids in industry are automatically titrated with suitable reagents in an apparatus which takes a measured sample, delivers it into a reaction vessel, and gradually adds

reagent until an end point is reached, when the vessel is emptied automatically and a fresh sample is delivered to it. The amount of reagent added each time is recorded on a chart. The end point may be indicated electrically, or by the formation of froth (as in the soap test for water hardness), or by some other device. By further mechanism, the result of the titration may be made to control valves by which reagents are added to the main bulk of the liquid. H.H.S.

Action of cement and gypsum on alkali and alkaline earth metals. J. MEYER AND KURT PUKALL. *Chemiker-Zeit.*, **78,** 757 (1927); *Tonind. Ztg.*, **51** [82], 1506 (1927). F.P.H.

Permeability of fused silica to ultra-violet rays. M. TSUKAMOTA. *Compt. rend.*, [1], 55–57 (1927); *Tonind. Ztg.*, **51** [80], 1472 (1927). F.P.H.

Phases formed when kaolin is heated. K. SPANGENBERG. *Fortschr. d. Mineral. Krystallogr. Petrogr.*, **11,** 340–43 (1927); *Tonind Ztg.*, **51** [80], 1472 (1927). F.P.H.

Measuring one-billionth of an inch. PHILIP CHAPIN JONES. *Min. and Met.*, **9** [253], 24–25 (1928).—Equipment to measure the changes in length to a billionth of an inch has recently been devised by P. P. Cioffi of the Bell Telephone Laboratories. The need for so refined an instrument arose from studies of magnetic materials. F.P.H.

Rapid determination of the magnesium oxide contents of dolomite. S. G. LASKY. *Rock Prod.*, **30** [25], 44 (1927).—The method of L. follows: Dissolve 1 g. of the sample in dilute HCl. Without filtering off any insoluble material, make strongly ammoniacal and add 2 or 3 drops of $(NH_4)_2S$ or its equivalent to precipitate any metallic sulphides. Heat to boiling and add enough $(NH_4)_2C_2O_4$ to bring down all the calcium. Filter, evaporate the filtrate which should contain all the magnesium to dryness, and ignite in the muffle for about 15 minutes. Weigh the residue as MgO, 1 mg. equaling 0.1%. It is unnecessary that the $(NH_4)_2C_2O_4$ be added in solution; the amount of magnesium mechanically entrained with the calcium is negligible insofar as it influences accuracy in this special operation. It does hasten work, however (which is the main reason for developing the method), to make and use a stock solution of such strength that the addition of about 20 cc. will precipitate the maximum possible quantity of calcium present. All the magnesium does not ignite to MgO, but there seems to be a constant error which takes care of this and gives results within the limits mentioned. A volumetric method was also tried in which the MgO is determined by difference through titrating for CaO and for total alkalinity in terms of CaO. The difference of the two, multiplied by the proper factor, 0.718, equals the MgO. This method is very short; but where the rock contains high percentages of MgO it gives results that are too high. F.P.H.

Plasticity of clays. W. MIEHR, H. IMMKE, AND J. KRATZERT. *Tonind. Ztg.*, **51** [76], 1381–84 (1927).—The historical phase of the subject is discussed. The subjects (1) behavior of a plastic body under external force and (2) the cause of plasticity are considered. The first subject was considered by Clerk Maxwell and the following differential equation derived:

$$\frac{dV}{dt} = \frac{1}{E} \cdot \frac{dK}{dt} + \frac{1}{\sigma} K$$

Where dV/dt = the change in deformation per unit time, K = the acting force, E = the modulus of elasticity. The second question has been considered by H. Salmang (see *Ceram. Abs.*, **6** [12], 622 (1927)).—The experimental part of this paper deals with the determination of the deformation produced by a given load when applied to a cylindrical test piece. The resultant height of the cylinder after the load is applied is plotted against the cubic centimeters of liquid added per 100 g. of clay. The liquids used in this set of experiments were water, glycerine-water mixtures, and castor oil and the amount varied. The apparatus used is that described by Pfefferkorn in *Sprechsaal*, **57,** 297–99 (1924). Plasticity is considered from the point of view of capillary phases. The assumption is

made that the formability of a plastic body is caused by the molecular properties of the liquid used for dilution. This is borne out in part by the experiments reported in this article. F.P.H.

Influence of water on recrystallization of some slightly soluble substances. BERNWARD GARRE. *Tonind. Ztg.*, **51** [79], 1440–42 (1927).—Reaction in the solid state is limited to the diffusion of the components. A series of experiments was conducted to determine the amount of diffusion taking place between very small grains of solids and the effect of water on this diffusion. The material to be tested was compressed under high pressure into small cylinders and various amounts of water added and the body heated to various temperatures. The amount of diffusion that had taken place between the grains of material was determined by the strength tests carried out on the cylinders. Finely ground quartz fired to 900°C showed increased strength as the amount of water added to the body increased. As the temperature of firing increased the strength of the body increased also. Similar tests were carried out on precipitated and fused alumina. The influence of the state of subdivision of the particles on the rate of diffusion is discussed. F.P.H.

BOOKS

Stereoscopic Photographs of Crystal Models. WILLIAM AND W. L. BRAGG. London: Adam Hilzer, Ltd., 1927. Price £2.1.0. Forty-two stereoscopic photographs of quartz, cristobalite, spinel, etc., complete in box with descriptions and folding stereoscope. The series includes 3 of Dr. Müller's universal X-ray spectrograph as set up respectively for the Debye, Bragg, and Laue, and rotating crystal methods. H.H.S.

Handbuch der Anorganischen Chemie. Part IV. O, S, Se, Te. Ed. by R. Abegg, F. Auerbach, and I. Koppel. Pp. xii+966. Leipzig: S. Hirzel, 1927. Price 64M. Deals with the elements of the sixth group of the periodic table. Reviewed commendingly in *Chem. and Ind.*, **46,** 1230 (1927). "Subjected to the searching test of use in connection with research, it has been found that nothing is omitted even of recent literature." H.H.S.

Einführung in die Kolloidchemie. W. OSTWALD. 10th ed., pp. xv+325. Dresden and Leipzig: Theodor Steinkopf, 1927. Price 12M. The 10th ed. of an epoch-making book which still conveys in part of its title that colloid chemistry is the world of neglected dimension. Reviewed in *Chem. and Ind.*, **46,** 1231 (1927). H.H.S.

Kolloidchemische Technologie. R. E. LIESEGANG and others. Pp. viii+1047. Dresden and Leipzig: Theodor Steinkopf, 1927. Price 70 M. Contributions by 30 well-known chemists on the whole field of colloid chemistry and its applications to technology. Reviewed in *Chem. and Ind.*, **46,** 1231 (1927). H.H.S.

Rothamsted Experimental Station Report 1925–1926. Pp. 156. Harpenden: Rothamsted Experimental Station, 1927. Price 2*s* 6*d*. Reviewed in *Nature*, Nov. 12, 700 (1927).—An account of field experiments, of progress in soil physics and soil microbiology. Soil resistance as measured by the dynamometer is illustrated, and other problems bear on soil texture as distinct from chemical properties. H.H.S.

Archimedes, or the Future of Physics. L. L. WHYTE. New York: E. P. Dutton and Co., 1927. Price 75 cents. H.H.S.

Preparation of Colloidal Solutions of Inorganic Materials. JOSEF REITSTÖTTER. 62 pp. 3 M. Theodor Steinkopf 1927. Dresden and Leipzig. *Tonind. Ztg.*, **51** [79], 1448 (1927). F.P.H.

PATENTS

Preparing titanic oxide from titanic ores. JEAN D'ANS AND FRITZ SOMMER. U. S. 1,655,940, Jan. 10, 1928. The process of producing titanium oxide from a titanium ore

containing iron, which comprises reacting upon such ore with concentrated sulphuric acid, in the proportions of substantially 1 part of ore to 2 parts of sulphuric acid and thereafter subjecting the reaction mixture to thorough contact with water in the proportion of substantially 1 part of water to each part of ore treated, subjecting the solution to a reducing agent to reduce the ferric sulphate to ferrous sulphate, eliminating ferrous sulphate by crystallization from the solution, and thereafter subjecting the mother liquor therefrom to a temperature above 150°C in an autoclave under pressure to precipitate the titanium oxide.

Separating chlorides of aluminum and potassium present in mixed solutions obtained in the treatment of leucite. GIAN ALBERTO BLANC. U. S. 1,656,769, Jan. 17, 1928. The process for the separation of the chlorides of aluminum and potassium present in the mixed solutions obtained by treating leucite with hydrochloric acid the process comprising the following steps in cyclical succession: (1) cooling the hot solution of the 2 chlorides down to the ambient temperature thereby causing the crystallization of most of the chloride of potassium of which remains dissolved only the amount which saturates the solution at the lowest temperature reached; (2) saturating with gaseous hydrochloric acid the liquid resulting from the operation (1) so as to cause the aluminum chloride it contains to precipitate in a crystalline state; (3) using the mother liquor saturated with hydrochloric gas, resulting from the operation (2) for attacking another charge of leucite and obtaining again a hot concentrated solution of aluminum and potassium chlorides.

General

Determination of the workability of plastic clays. SAMUEL J. MCDOWELL. *Jour. Amer. Ceram. Soc.*, **11** [2], 99–102 (1928).—A factory control test is described for determining the point at which workable plasticity is developed.

Possible future uses of clays. W. A. KOEHLER. *Jour. Amer. Ceram. Soc.*, **11** [2], 107–109 (1928).—The need for investigation of new uses for clays which may become necessary if new materials are substituted for brick is stressed. The shortcomings of brick, and possible new methods of clay processing are enumerated.

Science vs. engineering in the schools. A. F. GORTON. *Bull. Amer. Ceram. Soc.*, **7** [2], 27–33 (1928).—In discussing ceramic education it is suggested that (1) as it is the function of a technical school to impart as complete a scientific foundation as possible to its graduates, the tendency is to produce technologists rather than engineers; (2) engineering ability does not develop from formal training but from individual traits or inborn qualities; (3) the average-size plant should endeavor to make better use of the talents and ability of their so-called practical men by encouraging them to acquire technical knowledge through evening courses and extension work. The benefits of coöperative agreements with local educational institutions by maintaining scholarships are also pointed out.

The Ceramist's Tour Abroad. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **6** [12], 365–71 (1927).—A more detailed description of the itinerary to be followed in visiting France, Czechoslovakia, Germany, Holland, and England, May 19–July 5, 1928. Letters from friends of the AMERICAN CERAMIC SOCIETY in regard to the tour are reprinted.

E.J.V.

Integration of interests in ceramic technology. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **7** [1], 1–3 (1928).—The similarity of the various branches of ceramics in their fundamentals leads to a plea for a combination of interests in scientific and engineering problems relative to ceramic ware production. Four basic reasons for this plea are stated. The federation of ceramic groups in the employment of a research advisor with duties to serve each group, coördinating their interests in the ways and means of

obtaining and applying the science and engineering principles which will enable ceramic manufacturers to keep in the fore in the exceedingly rapid industrial progress of the times is pleaded for. E.J.V.

Suggestion for exhausted clay pit. ANON. *Brick Clay Rec.*, **71** [10], 710–13 (1927). —When the clay pit of the Hackensack, N. J., plant of Chas. F. Schultz and Son Co. was exhausted, the company secured a state contract to dredge the river for 7 miles above the plant. Two plants of the company and 3 outside companies are supplied with clay, and considerable outside work is done with the dredge when the supply of clay is sufficient for the needs. E.J.V.

Production without profit. ANON. *Brick Clay Rec.*, **71** [11], 770–74 (1927).—A discussion of the narrowing profit margin, its causes and possible cures, by some of the heavy clay industry's prominent men. E.J.V.

The Ceramic Society. ANON. *Pottery Gaz.*, **52** [606], 1919–23 (1927).—A report of the November meeting at Stoke-on-Trent. B. J. Moore and A. J. Campbell read a paper on "An Electric Enamel Tunnel Kiln," describing an 82-foot kiln being used at the Etruria factory of Josiah Wedgwood and Sons, Ltd., and the Minton china works at Stoke, for firing on glaze decorations with considerable success. Comparisons are drawn between this electric kiln and the coal-fired kilns previously used at Mintons. A discussion follows. In another paper on "The Utilization of Heat for Steam Raising," by G. Martin, the results of water tube and fire tube systems as applied to boilers are contrasted, and arguments adduced which are strongly in favor of the latter. E.J.V.

Face brick manufacturers convention. ANON. *Clay-Worker*, **88** [6], 451–53 (1927); *Brick Clay Rec.*, **71** [12], 863–68 (1927).—At the 16th annual convention of the American Face Brick Association held at Hot Springs, Va., steps were taken to strengthen the organization, to enlist the enthusiastic support of dealers, and the support of non-members was urged as the only possible solution of serious problems facing the industry. E.J.V.

Bureau of Mines, nonmetallic minerals station activities. OLIVER BOWLES. *Rock Prod.*, **30** [26], 169–70 (1927).—Work on the following problems is summarized: (1) effect of steam in lime kiln, (2) anhydrite in cement retardation, (3) investigation of sources of potash in the U. S., (4) metallurgical limestone, (5) recovery of fine-grained mica, (6) wire saw in slate quarrying, (7) mining, preparation, and testing of ochres and other mineral paints, (8) clays and feldspars of the northwest, (9) methods of milling fluorspar, (10) determination of the character, properties and action of various oil-bleaching clays, (11) study of bauxite concentration, (12) flotation of phosphate rock. F.P.H.

Chronic lead poisoning banished in N. J. potteries. P. E. SPRAGUE. *Ceram. Age*, **10** [4], 131–32 (1927).—The Bureau of Statistics, *Bull.*, No. 406, "Deaths from Lead Poisoning," by Dr. A. L. Hoffman, says that chronic lead poisoning (plumbism) is no longer an occupational hazard of serious concern, at least in the pottery industry. This conclusion is based on statistics from 1914 to 1924. A similar decline in chronic lead poisoning in the white lead industry is shown. This is attributed to regular medical inspection and methods of keeping away from dustiness. The hazard of lead poisoning has been a serious risk in the past in ceramic industries. The highest rate of certain cases was among dippers, with glaze mixers and miscellaneous men second. The most serious consequences are due to breathing contaminated dust into the mouth, when the contamination consists of red lead, yellow lead or litharge, or white lead, all of which are soluble in the body fluids. Methods of prevention are discussed. A.E.R.W.

Ceramic investigations at the Bureau of Standards. ANON. *Ceram. Age*, **10** [5], 157–64 (1927).—A complete report of the investigations which have been carried on at the Bureau of Standards during the past year. The objects, methods, and progress of the following investigations are described, and the apparatus and conclusions illus-

trated. Investigation of feldspar and its effect on pottery bodies, resistance of ceramic glazes to abrasion, effect of calcined cyanite in porcelain bodies, microstructure of earthen ware, a study of the composition and physical properties of glass, fundamental properties of fire clays and fireclay products, problems relating to sagger clays, physico-chemical factors affecting the consistency of enamel slips, effects of typical enamels on colors obtained with various stains, effects of composition on the properties of ground coat enamels for sheet steel, problems relating to the design of hollow tile and brick extrusion machines, cast iron for enameling purposes, physical properties of clay bodies as affected by the drying treatment, study of glazes, boiler furnace refractories, solid solution in the spinel minerals and relation to use in refractories, investigation of English and American china clays, and determination of characteristics of clays used in brick and allied products. A.E.R.W.

Ceramic industry in Czechoslovakia. RUDOLF BARTA. *Trans. Ceram. Soc.* [Eng.], **26** [2], 101–109 (1926–27).—After England, Czechoslovakia is the richest country in ceramic raw materials in Europe. The output there is so large that not only is the ceramic industry founded on a reliable basis, but nearly all the other countries of Central Europe are dependent on its clays, kaolins, and schists. It is 2nd in the world's production of kaolins, the output being estimated at 400,000 T. per year. The greatest number of deposits are located in northwestern Bohemia, where are also the largest kaolin mines. The best kaolin in Czechoslovakia is from Zettlitz near Carlsbad, where there is a group of mines belonging to the Kaolin Works Co. of Zettlitz. This kaolin occurs as nearly pure kaolinite (98 $^1/_2$% according to the Kallauner-Matejka method of rational analysis) and it is extraordinarily plastic. Czechoslovakia exports annually more than 20,000 T. of kaolin, and 80% of its value is exported to Germany, 10% to the succession states (Austria, Hungary, Yugoslavia, Rumania, and Poland, and 10% to Italy, France, Scandinavia, Spain, Switzerland, Belgium, etc. This country also possesses large quantities of refractory clays, faience clays, stoneware clays, etc., and figures with an output of 500,000 T. per year in the 4th place. The largest beds of refractory clays and stoneware clays are in Bohemia. More and more important becomes the electroösmosis of kaolins and clays. The proprietorship of the Schwerin patents for the Czechoslovak Republic is held by the Electro Osmose Society (Ltd.) in Carlsbad. There are in all two factories, both in Chodov near Carlsbad, the output of which amounts to more than 130 T. of refined kaolin per day. The annual production of feldspar attains 30,000 T. Quartz is marketed as vein quartz (generally ground), sandstone, quartzite or quartzitic sand, mostly as refuse from the production of kaolin. Czechoslovakian schists are known the world over, especially those of Rakovnik. Their refractoriness is Seger cone 36. The schists of Janusov in Moravia containing bauxitic materials are equally refractory (36–37). The most extensive ceramic industry is the manufacture of brick. The Hoffman is regarded as the best type of kiln, but there are also tunnel kilns in operation. The production of refractory ware in Bohemia is highly developed, corresponding with the large consumption at home, mostly by the iron, steel, coke, gas, sugar, glass, and ceramic industries, and other branches. Gas-fired kilns are considered best for this industry; 12,000 T. of crockery are exported annually, about $^1/_2$ to Austria, then to the Succession States and to other places. Very important buyers are the U. S. A., Canada, Bulgaria, Holland, Italy, and Switzerland. Stoneware sewer-pipe is produced in 15 factories with a yearly capacity of 50,000 T. but they are now making only 30% of this amount. Floor tile are manufactured in the standard size 150 x 150 x 10 mm. and in different colors. There are 12 factories with an annual capacity of 60,000 T. There are 10 factories of wall tile and 30 large factories of stoves. The annual production is 40,000 T., 25,000 T. of this amount being wall tile. There are 62 factories with the so-called chamber type of kilns or with tunnel kilns; 12,000 workers are employed. Crockery ware is produced by 39 factories, pots by 23, porcelain for

electrotechnical purposes by 13, technical and sanitary ware and pipe by 8, statuettes, objects of art, and fancy goods by 6. The Portland cement industry has developed greatly during the last few years. Since 1920 when the pre-war output was attained, the cement factories have increased production by over 100% so that for the year 1927 a production of 1,500,000 T. is to be expected. Magnesite deposits equal in quality to those of Austria. The yearly output amounts to 80,000 T. of which 60,000 T. raw and 70,000 T. burnt are exported to America, Germany, and Hungary. There are 25 factories of window glass; Fourcault machines are most popular. Cast and plate glass are manufactured in 9 factories, bottles in 10 factories, some with Owens machines. Hollow glass is produced in 103 factories with 11 tanks, and 236 kilns with 2,660 pots. There are 5 institutes where lectures on ceramic subjects are read. For the exploitation of mines the Higher Mining School in Pribram is very important. The center for the young ceramic engineers is the Czech Higher Polytechnical School in Brno; here the Institute of the Silicate Industry is one of the largest and best established ceramic institutes in Europe. It is under the direction of O. Kallauner. R.F.S.

Themes for clay workers. A. J. DALE. *Brit. Clayworker*, **36** [428], 276–78 (1927).—The following subjects are discussed: (1) the workability of clay; (2) the inter-relation of clayworking problems; (3) developments in kiln design and type of fuel; (4) heat insulation; (5) use of mechanical devices. The possibilities of increasing the workability of clays by various methods is covered with some thoughts expressed on new fields of research. The advantages and disadvantages of overpugging, fineness of flint in whiteware body, overcalcination of flint, certain soluble salts, rapidity of drying, adoption of different type of kiln, and thermal insulation are outlined. Heat insulation not only conserves a large amount of fuel but also has the advantages of much smaller temperature difference between tops and bottoms of kilns, and an appreciable reduction in firing time as a consequence of more uniform temperature distribution. R.A.H.

Investigations of the Bureau of Standards aid industries. GEORGE K. BURGESS. *Amer. Glass Rev.*, **47** [10], 15 (1927).—B., who is director of the Bureau of Standards, reports that of the 150,000 tests carried on last year by the Bureau, nearly $^1/_2$ dealt with industrial problems, which were carried on in coöperation with more than 200 scientific, technical, and industrial organizations. It is reported that in addition there are 63 "research associates," sponsored by industrial groups representing 36 different fields, and now supplying their representative firms with new discoveries and improved processes, which are quickly applied industrially. The total fees collected to date for these tests netted nearly $500,000. Many tests were made on substitutes for window glass and some of these are now available on the market. A total of 21,000 lbs. of optical glass was made and 21,441 blanks for lenses and prisms were supplied by the Bureau to the optical shop of the Navy Dept. A very large disk suitable for the mirror of a reflecting telescope was cast by a new method. This disk is 70 in. in diameter and 12 $^1/_2$ in. thick. This was cast last May, but due to the slow cooling process employed, it will not be removed from the furnace until February. Several recommendations are made: (1) An increased appropriation for fundamental research and testing; (2) increased support for branch laboratories; and (3) consolidation of numerous funds, under which the Bureau operates, thereby lessening administrative routine. P.F.C.

A new kind of camera. ANON. *Nat. Glass Budget*, **43** [35], 10 (1927).—A moving film camera which photographs gas and coal dust mine explosions is reported as invented by J. E. Tiffany of the U. S. Bureau of Mines. It will be used in the development of "permissible" explosives designed to meet the need for an explosion less liable to ignite the air in the mines. It is part of a program of research into causes of mine explosions being made by the experiment station. P.F.C.

Ceramic outlook for 1928. ANON. *Ceram. Ind.*, **10** [1], 39–40 (1928).—Means for increasing the sale of ceramic products is a most important item to the ceramic manu-

facturer. The glass container industry is now equipped to make far more ware than consumption requires; the sanitary ware industry is being crowded by over-production; sheet and plate glass is fighting foreign competition; dinnerware manufacturers for the most part are not in any too healthy condition partly due to neglect of modernizing their plants and to foreign competition; enameled utensil manufacturers have a private struggle among themselves and must also combat the new glass, china, and aluminum cooking ware that is coming so rapidly to the front. Stove manufacturers are faced with the possibility of making small stoves, due to the increase of small apartments which seem to be the vogue. Substitutes for ceramic products such as "pollopas" the organic glass, various floor and wall tile substitutes such as catlin, Belgian tile, rubber tile, cement tile, etc., are bound to affect the production of ceramic ware. By making great efforts to increase the sales of their products, ceramic manufacturers will aid in damming the encroachment of the flood of both substitutes and the continual bombardment of foreign wares. F.P.H.

Cost of selling. GEORGE A. WILSON. *Ceram. Ind.*, **10** [1], 42–47 (1928).—An address delivered before the American Face Brick Association in convention at Hot Springs, Va. W. deals with budget control and modern merchandising. F.P.H.

Potters predict labor crisis. ANON. *Ceram. Ind.*, **10** [1], 70–76 (1928).—A report is given of the 49th annual convention of the U. S. Potters Assn., held at Washington, D. C. The general sentiment voiced was that in spite of the heavy burden imposed upon the industry by the wage scales now in effect for skilled operatives, there is no desire to lower these wage scales for skilled workers; but it is imperative that unskilled tasks be segr gated from those calling for craftsmanship. If remuneration for unskilled tasks is adjusted on a fair basis, detached from the considerations governing the pay for skilled artisans, and commensurate with what ordinary labor commands in other industries, further thinning of the ranks of American pottery manufacturers (and with it much more disastrous consequences for the skilled operatives through unemployment) may be averted. F.P.H.

Demand for English ceramic ware drops. ANON. *Ceram. Ind.*, **10** [1], 76 (1928).—Manufacturers look for greater development in Canada. F.P.H.

Research and technology. ANON. *Ceram. Ind.*, **10** [1], 78–80 (1928).—A report is given of the American Refractories Institute Meeting held at St. Louis, Mo., Dec. 6–7, 1927. The chief technical subjects considered at this meeting are summarized as follows: (1) spalling, (2) hot water in pugging, (3) test reheating brick, (4) drying, (5) special refractories, (6) simplification of malleable refractories, (7) symposium on tunnel kilns with figures on labor and fuel used. F.P.H.

New products in the ceramic industry. ANON. *Ceram. Ind.*, **10** [1], 94 (1928).—The following new products are described: (1) a glass lined laundry chute, (2) an electric toaster of vitrified china, (3) a sink that does away with dish pans, (4) low pressure refrigerators. F.P.H.

Eighth convention of the German Ceramic Society. ANON. *Keramos*, **6** [9], 333–34; [11], 427–37 (1927); *Ber. deut. keram. Ges.*, **8** [4], 234–38 (1927).—The papers abstracted are as follows: (1) "Methods and Equipment for the Drying of Ceramic Products," by L. Wirth. (2) "Variation of the Constitution of Clay Caused by Heat," by W. Miehr. (3) "Action of Slag on Refractory Materials," by F. Hartmann. (4) "The Working Out of Time Studies in Practice," by Helm. (5) "X-ray Methods of Research with Special Reference to Ceramic Products," by Gottfried. (6) "Glaze Coating and the Stalactite Formation in the Tunnel Kiln," by Berdel. (7) "Strain in Glazed Ware and Its Detection," by W. Steger. F.P.H.

The mechanical engineer in the ceramic plant. K. SCHMARJE. *Keramos*, **6** [11], 423–25 (1927). F.P.H.

Mining engineering education. WILLIAM B. PLANK. *Min. and Met.*, **9** [253], 5–8 (1928).—A concise summary of the results of a study of questionnaires submitted to 300 members of the American Institute of Mining Engineers. F.P.H.

Determining friction losses in water pipe. F. J. WALTER. *Rock Prod.*, **30** [24], 74–75 (1927). F.P.H.

Roofing and coating materials from coal-mine dumps. WM. A. FORBES. *Amer. Iron Steel Inst.*, Advance Paper, N. Y. Meeting, pp. 16–17 (1927).—Research on the utilization of waste material from coal mining operations has recently developed a processing system to make a building product from the slaty material occurring in burnt-out refuse dumps. The material, consisting chiefly of calcined fire clay, is crushed, sized, and treated to produce roofing or coating of several shades of red and brown. In the treatment process, special pickling liquor from steel mills is used. Thus the combination of two waste products makes a new high-grade material. H.H.S.

British Association meeting 1928. ANON. *Chem. and Ind.*, **46**, 1152 (1927).—The meeting will be in Glasgow Sept. 5–12. Sir William Bragg, president; A. W. Porter, president of Section A, mathematics and physics; E. C. C. Baly, president of Section B, chemistry. H.H.S.

British Industrial Museum. ANON. *Chem. and Ind.*, **46**, 1186 (1927).—The Home Office Industrial Museum in Horseferry Road, London, was officially opened on Dec. 3. Among the exhibits are pottery processes, boilers and other steam plant, lathes, drilling machines, grinding wheels, transmission machinery, and power presses. An important section is devoted to industrial disease; included in it are photographs showing methods for the prevention of lead poisoning, silicosis, and dermatitis. H.H.S.

Book Reviews

Annual Survey of American Chemistry. II. Edited by Clarence J. West. Chemical Catalog Co., Inc. Price $3.00. Chapters touching on ceramic problems are: "Determination of Crystal Structure by X-Rays," by Ralph W. G. Wyckoff; "X-Ray Examination of Materials," by George L. Clark; "Inorganic Salts," by James R. Withrow; "The Common Earths," by Robert B. Sosman; "Glass," by George W. Morey; "Clay Products," by Alfred V. Bleininger; and "Coal, Coke, and Gaseous Fuels," by Arno C. Fieldner.

The Technique of Vitreous Enameling is a 200-page text book published by the Ferro Enameling Company of Cleveland, Ohio, devoted to sheet steel and cast-iron porcelain enameling by the wet process. It is well explained with pictures, charts, and data, and is interesting as well as instructive. The book takes up, both from a technical and practical standpoint, difficulties and troubles in an enameling shop, and points out the precautions to be taken in order to prevent them. It outlines a complete course of action for a well-regulated and smoothly-running shop. Part of the book is devoted to colors and color matching, mill additions, and percentages for same. The price of the book is $3.50.

Correction

The following statement has been received from E. C. Sullivan, vice president in charge of manufacturing of Corning Glass Works.

Ceramic Abstracts, **6** [7], 274 (1927), contains what purports to be an abstract of a paper by H. Thiene, on "Post-War Laboratory Glassware," in which the statement is made that "even in 1912 frying pans and baking dishes were made (*e.g.*, out of Durax glass)" by the Jena Glass Works. This statement does not appear in the original article, which contains no specific mention of frying pans or baking dishes or of the date 1912, and no intimation that Durax glass was used for household ware.

The abstract in *Ceramic Abstracts* is credited to the Society of Glass Technology. Examination of Dr. Thiene's paper in *Zeitschrift für angewandte Chemie* and of an article in *Keramische Rundschau*, which was the direct source of the English abstract, discloses that *Keramische Rundschau* has brought forward in the guise of an abstract considerable material not in the original. Our friends, the Jena Glass Works, with which Dr. Thiene is associated, have written us that the statement quoted is altogether erroneous.

Inasmuch as Jena specifically acknowledges that Corning Glass Works is the originator of glass baking dishes we feel that you will wish to make some correction of the wrong impression which might be created by the abstract as published in *Ceramic Abstracts*.

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THREE INSTRUCTORS *Head of Department:* PAUL E. COX

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THE CERAMIC INDUSTRIES

BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

E. DEF. CURTIS, MARION FOSDICK, H. G. WOLFRAM, W. N. HARRISON	Art, Enamel	C. D. SPENCER, G. W. COOPER, L. J. TROSTEL, C. F. GEIGER, H. P. HUMPHREYS, R. F. SHERWOOD	Glass, Refractories, White Wares	H. E. DAVIS, F. S. SCHEPERS, C. A. NICELY, G. A. BOLE	Terra Cotta, Heavy Clay Products

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Vol. 7 March, 1928 No. 3

EDITORIAL

THE ART DIVISION, 1928

BY E. DEF. CURTIS

The Art Division of the AMERICAN CERAMIC SOCIETY is concerned with all ceramic materials, processes, and products that depend to any extent whatsoever on artistic merit. The Art Division is also concerned with the education of the artists and technicians who produce these wares, and with their use and appreciation by the public.

To successfully live up to such a broad program requires close coöperation of many active experienced specialists; these we have in the SOCIETY membership but under the present organization they are not available in the Division. The cause of ceramic art is a worthy one, and one in which each of us is fundamentally interested, whether we are making bricks or table ware. The person who has worked in clay cannot fail to thrill at the sight of a really beautiful pot or an artistic effect in brick masonry.

The various points that have drawn attention of ceramic artists will be briefly discussed.

[1] Received January 9, 1928.

Grade School Education

The school children of today are tomorrow's buying public; the more they know about clay, its nature and uses in every day life, the more they will be interested in clay products later; the more their taste is trained and developed now, the more they will appreciate fine work in their own homes. Today we have a popular school method of decorating badly made, unfired clay objects with show card colors and as an indirect result we have a slogan in the trade, "Paris for styles in clothes, England for styles in dishes." Just as we teach children to appreciate beautiful pictures, so ought we to develop their taste in beautiful ceramics and later they will look for the beauty of the thing and not for the "imported" sign. Clay work is generally valued highly by educators but the possibilities are made very little of, partly because of lack of training and understanding of the material by the teachers and partly because of the difficulties in firing in schools and the lack of inexpensive equipment and simple text books.

The Art Division can survey this field and publish a small booklet of fundamental information that would make very radical improvement. The printing cost could be covered by advertising.

Vocational Training

This part of the work has been started by the Ohio Ceramic Industries Association and the General Education Committee of this SOCIETY. There is a definite need for a simple text book introducing the subject of ceramic art including a bibliography to help those students whose interest is seriously aroused. The Art Division can collaborate with those who are in touch with the vocational schools and accomplish some definite good.

The Professional Craftsman

One of the really great things that life has given to the writer is his own small pot shop and while we should not advise any one to deliberately go into that field without counting the cost, we are sure there will be an ever-increasing number drawn into it and we should like to feel that by some contribution we have made it possible for other would-be potters to avoid the handicaps.

Of the potters we know, some have been artists, some technicians; none of them have had both artistic and technical training as wel as shop experience. Those who have made the greatest success have been strongest in a sense of design. There should be some provision made for these people to get the part of their training that they lack, but they are so few and so scattered that it will have to be done through text books or else at some one school specializing on a craftsman course of

study. The Art Division could produce such a book for normal and industrial art school work.

The Nonprofessional Craftsman

This applies to those who do not care to make money, and there are many who take up pottery as a means of artistic expression just as many take up painting or perhaps as part of a course in occupational therapy.

The Art Division here can survey the situation to see how best these people can keep on with their work after the school equipment is closed to them and to recommend some standard methods for work in occupational therapy that will avoid the severe disappointments that are so bad for mental cases.

Normal and Teacher Training Courses

Every person who is going to teach art should know how to make a piece of pottery and should know the ceramic processes and have some appreciation of the artistic possibilities of clay. A twenty-page pamphlet and fifty hours of laboratory work would give them this fundamental training.

Schools of Industrial Art

Here is the greatest stumbling block for the advancement of ceramic art. This type of school ought to feed the indu try with professional designers, but the school attitude so often is that we must teach something better than the factories are doing or we shall fall short of our responsibilities; we must not cater to the industry; and in holding to this perfectly justified ideal, we miss the opportunity of learning the real problems that the factory wants solved; get the industrial art schools working on actual factory problems, putting their best teaching into it and we shall begin to turn out well-trained men who can earn their way in the industry because they are of real value.

How much chance is there for a ceramic artist to get work after he has completed his studies? We all know that there is plenty of room for improved design, but do we know the economic ramifications in each phase of ceramic work that may nullify the value of a trained artist? Where do the men who model for the terra cotta plants come from now? Could a small school afford to pay a teacher of ornament and sculpture capable of turning out this class? How about the dinner ware designers: are they dependent on the decalcomania firms to such an extent that only a few artists each year could be absorbed? What about the tile men? Are they dependent on the architect, or on the other hand, is there a definite field for firms of ceramic designers and for salesmen who can get business through their artistic ability?

Now, when there is a good deal of interest in this subject, is the time for the Art Division, working with the various groups that employ artists to make a full and impartial investigation and see just what kind of artist is actually needed. The Art Division is the logical place to find a common meeting ground for those who are making ceramic artists and those who are going to use them.

These educational problems include most of the actual problems that come up in industrial work. If we can get a firm foundation along the lines which are indicated here we shall be in a fair way to introduce more trained artists into the industries.

We have talked to some of the members of the American Institute of Architects and they seem interested in any attempt to create a better understanding of ceramic materials and their use among the younger architects. Perhaps the brick and tile and terra cotta men could accomplish more through a disinterested group such as the Art Division than they could by direct means.

We have talked to retailers of table ware. Some think that the American factory does not want the market that now goes to the English earthenware manufacturers because it does not run into volume business but nearly all are convinced that the American public wants something imported, no matter from where it is imported.

Why not use the Art Division to survey this field and see how the condition might be changed? It is hard to beleive that the value of replaced American ware, some eighteen million dollars, as nearly as it could be figured out from the sheets of the Department of Commerce, is not large enough to interest some of our plants. If it does interest us why can we not have our share of that business? Is it design, is it color, is it style, or is it the whim of the public, which after all can be influenced if anyone really wants to influence it.

The one point that has come to light this year against which we ought to take the strongest possible stand is the pirating of designs. There can be nothing more deadening to the incentive to creative work than to get out a good design and have it copied. I should like to hear if there is any way in which the design can be protected and if so why it is not used. If there is no possible protection how can we meet the situation because any structure we raise to develop ceramic artists will fall down under a system of pirating of this kind.

I have read over the *Journals* for several years and have found several carefully worked out plans for the Art Division, many splendid suggestions and recommendations, all made and lost in the files without action. One of our greatest problems is to find a way to translate our well-considered judgments into action and enduring form. The committe plan is too indefinite, the responsibility too vague, and the ap-

parent lack of interest too real. Whether that would mean an increase in dues with a definite part of it to go for Division purposes or whether it means obtaining the authority to take subscriptions from outside the membership, or an increase in members we do not know; but we feel that there should be a paid person in the Division to keep the movement active. It might be done by means of scholarships donated for the purpose in return for which the student would do work under the direction of the officers. It is too big and important a work to be allowed to drag along with only the time volunteers can give to it.

There are many possible members who could be attracted and held by the SOCIETY if we offered them something each month of interest to them. Art teachers and students want a very different journal than the engineering group; why not issue a separate monthly folder for them and try for their active support and interest?

There are many activities the Division could undertake if we had some sort of a fund: travelling exhibitions, lectures, text books, scholarships, publicity work. Do we want any of these things enough to put them through or shall we be content to say it all over again a year or so from now?

In short the Division needs a survey of each phase of our activities, active participation in its affairs by those who know industrial conditions and problems, inexpensive tools and text books, a bibliography, and above all a definite campaign and some means of making it real. All of which we can have if there is the will to do it.

ACTIVITIES OF THE SOCIETY

CERAMISTS' TOUR ABROAD

The party sails from New York May 19 on the Cunard liner S. S. Tuscania.

Return from Liverpool June 30, arriving in U. S. July 5.

Cost, $900 per person, includes all transportation, food, and lodging on sea and land from New York City and return.

Factories making all sorts of clay, glass, and glass enameled wares are inviting Americans to visit them in France, Germany, Czechoslovakia, Holland, and England.

Special receptions and meetings are arranged.

Special entertainment for ladies. Post tour trips to plants of special interest and to countries not covered by this special limited itinerary are being arranged on request. Write Ceramists' Tour Department, Suite 656, 25 Broadway, New York City, for details and look for the special booklet, now on the press, containing further details.

For a real instructive and inspiring vacation, an unusual opportunity to see ceramics manufactured abroad, and for opportunity to meet the industrial leaders in the several countries abroad, this Ceramists' Tour is the best and the most economical ever offered and one you can ill afford to miss.

The Wedgwood, An Example of Historical Plants To Be Visited.[1]

One hundred and ninety-eight years ago Josiah Wedgwood was born in Burslem, the mother town of the Staffordshire Potteries. He came of a race of Master Potters, who for four generations had made "pots."

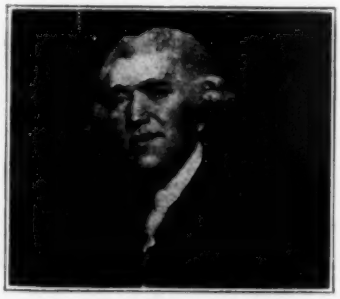


FIG. 1.—Josiah Wedgwood, F.R.S. From a painting by Sir Joshua Reynolds, P.R.A.

Beginning as a lad unaided by wealth, influence, or renown, he touched the life of his generation at many points, in politics, education, engineering, and chemistry. He has been justly called the Father of English Pottery.

Industrial progress, invention, and discovery was the field of Wedgwood's operations, and here his mind was alert from first to last.

The dwelling house in which he was born was attached to the Churchyard Works belonging to his father, and it was here he started his career as a potter at nine years of age

[1] By Harry Barnard, Curator of Etruria Museum, Stoke-on-Trent.

with his brother Thomas, after the death of his father. At fourteen years of age he was apprenticed for five years.

In 1759 Josiah Wedgwood rented the small Ivy House and Works at Burslem and thus started an enterprise which has meant so much to the pottery industry ever since.

His experiments and improvements in cream colored ware, soon superseded the salt glazed ware, and in two years after many failures and losses, his efforts were successful and excellence was attained. His ware showed delicacy of finish and brilliant glaze, which, combined with an entirely new range of shapes soon drew the attention of buyers and the patronage of people of taste, including royalty and nobility, for Queen Charlotte, the wife of George III, gave her patronage and commands for table ware. From that time this cream colored ware became known as "Queensware."

FIG. 2.—Queensware (Queen's Shape).

In 1764 his business had increased and it became necessary to move to larger works, "The Brick House Works," but again this proved inadequate for the rapid development which soon began to overwhelm these new premises; so he bought the Ridge House Estate, and built new works and a village for his workpeople upon it.

This he called "Etruria," and it was opened June 13, 1769, Wedgwood himself "throwing" the first six vases while his partner, Thomas Bentley, turned the wheel. These vases bore the legend of his own creation, "Artes Etruriae Renascuntur" (one of these can be seen in the Etruria Museum on the Works today).

Thus the new "Etruria" was started and the ancient art of Italy reborn, in a truly revived semblance. The classic "motif" received a more chaste rendering of its subjects, which was in accord with the English feeling.

From this time forward Wedgwood's whole life was a constant routine of research. He acquired and experimented with any materials that offered promise of success (whether they were natural clays or minerals) for producing his various wares, or tools, and machinery for improving his processes of manufacture, or in the equally essential direction of seeking out and utilizing the services of the best artists and craftsmen of the day.

Visitors to the Etruria Museum can verify these facts in the fullest manner; time enough is the only necessary factor.

By gradual and sure steps he ascended the pinnacle of fame in the ceramic world where his name rests today.

Turnpike roadmaking engrossed his attention at times for he saw plainly that, improve his manufacture in what ways he might, it would he useless unless he brought the potteries into closer communication with the highways of commerce; therefore he turned his attention and that of his brother manufacturers to the condition of the muddy unmade lanes that separated the potteries from other towns, and they besought the local powers with success.

Canal making also occupied his earnest attention, and much valuable time he spent with James Brindley, the Duke of Bridgewater's engineer, working strenuously, also with success, for the construction of the Trent and Mersey Canal and its branches, which connected the potteries and Birmingham with Lancashire and the North and Irish Seas.

FIG. 4.—Enamel Printed Queensware. (Trentham pattern).

The canal to him was a great business tool (it passed right in front of the Works at Etruria) superior in every way to that which it replaced.

Wedgwood introduced efficiency into everything he undertook. In "pot making" he abolished the old method that had satisfied his ancestors and insisted that his wares should be good to look at, good to use; his teapot lids fitted, their spouts poured, their handles balanced well and fulfilled their purpose.

Practical need drew him to scientific experiment. He saw the value of certain chemical compounds, and he manufactured his jasper, he studied the effect of fire upon infusible clays, which led to the invention of his "pyrometer," and his election as a Fellow of the Royal Society.

He was not a great chemist, even judged by the standards of his own day, but his researches aroused the keenest interest of Lavoisier, one of the most original chemists in Paris.

Dr. Mellor, the present Principal of the School of Science and Technology, Stoke-on-Trent, has written recently: "Wedgwood's private note books teem with records of experiments in ceramic chemistry which would be creditable were they published tomorrow."

All this leads one to ask, "What is Wedgwood?" The inquiry like

the proverbial snowball, seems to grow in volume as it rolls on. It is perfectly amazing how little the ordinary individual knows about the types and classes of the ware produced by this time-honored firm.

If a piece of ware has the merest suggestion of a classic figure or design upon a blue ground, in many eyes without doubt it must be Wedgwood. There are still those who are surprised to learn that other ware than "blue with white figures" is made at Etruria.

FIG. 4. — Vase No. 1200 on jasper ware.

The members of the Ceramists' Tour Abroad will of course know better before they start, but even they no doubt will find surprises before they have concluded their trip round the old works at Etruria.

The famous "Master Potter," whose name is revered wherever "pots" are made really covered the whole range of ceramics, though at first only earthenware in which he excelled and which has been a staple output from the Works ever since. Black ware, a vitreous porcelain which he named "Basaltes," became a very inportant product. Made both in useful and ornamental ware, it has held its own and the very great variety of busts and figures in this material have always been sought after by collectors and connoisseurs.

The beautiful jasper ware followed and occupied much of his time during the decade 1770 to 1780 after which some of the most beautiful "tablets" were made in this material and later the very fine vases which are so well known and have been so eagerly acquired for museums and private collections.

FIG. 5. — John Wesley. Bust in basaltes.

The less known wares, such as cane colored and celadon colored earthenwares (green glazed ware, better known to our grandparents). Mortars and pestles and chemical ware are still produced.

English bone china has since 1879 been made in ware suitable for all uses of the table as well as in many types of ornamental vases and ornaments.

Such utilitarian wares as scale plates, shop dishes, and pans, sanitary ware, and tile of all descriptions have had long and important sojourn in the old factory.

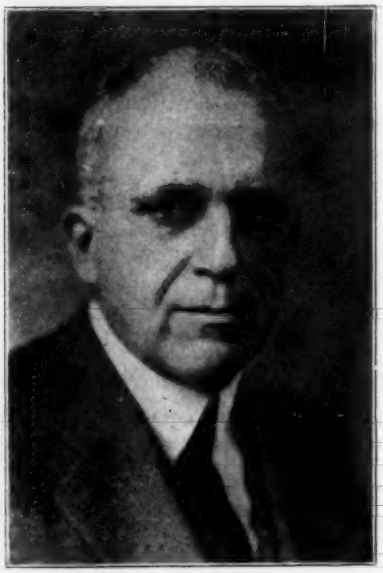
So then the answer to this question, "What is Wedgwood?" may be summed up in a sentence: "It is the experience and hereditary handicraft of nearly 170 years, and is represented today by the fifth and sixth generations of both masters and workpeople, linking all up to the original founder without any break through the six generations. It is ware made by Josiah Wedgwood and Sons, Ltd., the direct descendants of the great potter, and the heirs of his traditions."

THE ANNUAL MEETING

Held at Atlantic City, N. J., February 5–9, 1928

Approximately seven hundred members of the AMERICAN CERAMIC SOCIETY met at Atlantic City, N. J., Hotel Ambassador on February 5–9, 1928, for the Thirtieth Annual Meeting. Members of the National Brick Manufacturers Association, meeting concurrently with the Heavy Clay Products Division of the SOCIETY registered several hundred members.

While the Atlantic seaboard is off center for many ceramists and there was not the usual increase in registration, those who attended left with the satisfaction of close personal contact with many ceramic friends and benefited by the high grade of technical papers and their ensuing discussions.



CHARLES R. STEVENSON

GEORGE T. TRUNDLE

The general sessions, the technical meetings, and the social gatherings were unusually closely attended.

The Local Committee, headed by D. Parry Forst and J. A. Williams, deserves much credit for the unusually fine program presented at the banquet on Wednesday evening. The toastmaster, B. Mifflin Hood, retiring president of the AMERICAN CERAMIC SOCIETY, spoke with his usual fluency and keenness. The President of Rutgers University, John Martin Thomas, presented an excellent address on the significance of ceramic education. Judge Wells of Bordentown, N. J., gave an excellent address and the Happiness Brothers of radio fame added their songs and quips to conclude the program. The induction of new officers was conducted by R. L. Clare, past president of the SOCIETY.

The Enamelist dinner on Tuesday evening, which has been an annual affair was attended by about one hundred men from the enamel industry. On Monday and Tuesday evenings the various schools held their annual reunion dinners.

By vote of the Board of Trustees the 1929 Meeting will be held in Chicago, Illinois.

D. F. Albery, chairman of the Chicago local committee is already active on the plans for this Meeting.

Special Speakers on Monday

At the General Sessions held on Monday morning, February 5, four men spoke on plant management and industrial economics.

Charles W. Lytle of New York University, chose "Industrial Coöperation" as his subject. Mr. Lytle is a graduate of the University of Cincinnati, mechanical engineering coöperative course, and became instructor, first at Rochester Mechanic Institute, then the Georgia School of Technology, and later at Harvard. He has been a leader since 1923 of the Management Division of the American Society of Mechanical Engineers, first as secretary and then as chairman. He is the author of several papers and books on management.

CHARLES W. LYTLE

HAROLD K. FERGUSON

Harold K. Ferguson of the H. K. Ferguson Co., Cleveland, Ohio, talked on "Meeting the New Competition with Planned Management." Mr. Ferguson, for several years, has been in close association with many of the leading manufacturing concerns in the country, through the large volume of engineering and construction work which his firm has handled. He has made a wide study of the modern economic trends that have brought about this "new competition," and brought an important message to the ceramic members on sound methods of management.

"Management and Machinery," was the subject chosen by George T. Trundle, Trundle Engineering Co., Cleveland, Ohio. Mr. Trundle was chief engineer in charge of production at the American Multigraph Co., from 1907–1919. In 1919 he became consulting and investigating engineer, specializing in plant design and layout, designing special purpose machines and methods, plant organization scheduling and control, power and fuel service, experimental and research directing.

Charles R. Stevenson, of Stevenson, Harrison and Jordan, New York City, chose as his subject "The Economic Effect of Taking Business below Cost." For the last three years, Mr. Stevenson has been a member of the above firm, and for seven years preceding, a member of the Stevenson Corporation. He has spent twenty-five years in actual industrial management and engineering work, serving many of the largest and most successful companies in this country and Canada.

Officers of the American Ceramic Society for 1928–29

The newly elected officers of the AMERICAN CERAMIC SOCIETY for 1928–29 are as follows:

President: Macdonald C. Booze, Charles Taylor Sons Co., Cincinnati, Ohio.
Vice President: Ralph R. Danielson, Metal and Thermit Corp., Elizabeth, N. J.
Treasurer: H. B. Henderson, Standard Pyrometric Cone Co., Columbus, Ohio.
General Secretary: R. C. Purdy, 2525 North High St., Columbus, Ohio.

Art Division

Chairman: E. deF. Curtis, Philadelphia Museum and School of Industrial Art, Philadelphia, Pa.
Secretary: Marion Fosdick, New York School of Clayworking and Ceramics, Alfred, N. Y.
Trustee: E. deF. Curtis.

Enamel Division

Chairman: H. G. Wolfram, Porcelain Enamel and Mfg. Co., Baltimore, Md.
Secretary, W. N. Harrison, Bureau of Standards, Washington, D. C.
Trustee: B. T. Sweeley, Baltimore Enamel and Novelty Co., Baltimore, Md.

Glass Division

Chairman: C. D. Spencer, National Lamp Works, General Electric Company, Nela Park, Cleveland, Ohio.
Secretary: G. W. Cooper: *Glass Industry* (Editor), 50 Church St., New York City.
Trustee: J. C. Hostetter, Corning Glass Works, Little Falls, R. I.

Heavy Clay Products Division

Chairman: C. A. Nicely, Watsontown Brick Co., Watsontown, Pa.
Secretary, G. A. Bole, Lord Hall, O.S.U., Columbus, Ohio.
Trustee: Geo. W. Denison, Ohio Clay Co., Cleveland Ohio.

Refractories Division

Chairman: L. J. Trostel, General Refractories Co., Baltimore, Md.
Secretary: C. F. Geiger, The Carborundum Co., Perth Amboy, N. J.
Trustee: F. A. Harvey, General Refractories Co., Pittsburgh, Pa.

Terra Cotta Division

Chairman: H. E. Davis, Federal Terra Cotta Co., Woodbridge, N. J.
Secretary: F. S. Schepers, American Terra Cotta and Ceramics Co., Crystal Lake, Ill.
Trustee: E. C. Hill, Conkling-Armstrong Terra Cotta Co., Philadelphia, Pa.

White Wares Division

Chairman: H. P. Humphrey, Washington Iron Works, Washington, N. J.
Secretary: R. F. Sherwood, Pass and Seymour, Solvay, N. Y.
Trustee: A. V. Bleininger, Homer Laughlin China Co., Newell, W. Va.

AMERICAN CERAMIC SOCIETY INVITED TO CANADA FOR 1930

The officers of the Canadian National Clay Products Association has issued an urgent invitation to the AMERICAN CERAMIC SOCIETY and the National Brick Manufacturers Association to hold the 1930 meeting in Toronto, Canada. This invitation is signed by Gordon C. Keith, Secretary of the Canadian Association and also the follow-

ing persons: H. F. Dingledine, A. F. Greaves-Walker, Chas. A. Millar, Wm. Burgess, Howells Frechette, R. J. Montgomery, F. R. McCannell, S. Stone, Robert W. New, and Ryland H. New.

NEW MEMBERS RECEIVED FROM JANUARY 1 TO FEBRUARY 1

CORPORATION

The Cowles Detergent Co., 7016 Euclid Ave., Cleveland, Ohio, E. L. Bassett, Treasurer and General Manager.

Moffats Ltd., Stove Manufacturers, Dennison Ave., Weston, Ontario, Frederick W. Moffat, Manager.

Tavern Rock Sand Co., Millville, N. J.

PERSONAL

M. L. Begeman, Engineer, Mississippi Glass Co., 110 E. Ferry St., St. Louis, Mo.

Ernest J. Brunning, 202 Ballantyne Ave., North, Montreal, Canada; Works Manager, Consumers Glass Co., Ltd.

R. R. Cole, Federal Abrasives Co., Anniston, Ala.

Eduard Cronn, Sr., Superintendent, Steingutfabrik Schwarzwald G.m.b.H., Hornberg, Germany.

A. P. M. Fleming, Metropolitan Vickers Electrical Co., Manchester, England.

John N. Frank, Ceramic Dept., Oklahoma State University, Norman, Okla.

Thomas B. Gotham, Burlinghame, Calif. Ceramist, West Coast Porcelain Mfg. Co., Millbrae, Calif.

R. W. Hawley, Pacific Clay Products Co., Glendale, Calif.

Ernest M. Hommel, 5881 Douglas Ave., Pittsburgh, Pa., Salesman, O. Hommel Co.

H. J. C. Johnston, Director, Leeds Fire Clay Co., Wortley Leeds, England.

Paul Gordon Kelley, Ceramic Instructor, High School, East Liverpool, Ohio.

Henry Edward Marley, 3620 Terrace St., Pittsburgh, Pa., Ceramic Engineer, Koppers Co., Laboratories, Mellon Institute.

George McKerrow, Research Engineer, "Dorrator." The Firs, Bowdon, Cheshire, England.

William H. Merry, Chemist, Rundle Mfg. Co., Milwaukee, Wis.

C. G. Metsch, Secretary and Treasurer, Potters Mining and Milling Co., East Liverpool, Ohio.

Lewis E. Mong, Bureau of Standards, Washington, D. C., Junior Engineer.

Mulkh Raj Nayar, Dept. of Ceramics and Industrial Chemistry, Benares Hindoo Univ., Benares, India.

Austin J. Paul, Ceramic Engineer, Missouri Clay Testing and Research Laboratories, Rolla, Mo.

Raymond B. Saylor, Representative Operating Dept., American Sheet and Tin Plate Co., Sharpsburg, Pa.

William A. Watson, Salesman, General Refractories Co., 1159 Leader Bldg., Cleveland, Ohio.

William M. Weigel, Mineral Technologist, Missouri Pacific Railway, 1257 Rwy. Exchange Bldg., St. Louis, Mo.

Wilmer L. Wright, Electrical Engineer, General Electric Co., Schenectady, N. Y.

STUDENT

Abde Ally, New York School of Clayworking and Ceramics, Alfred, N. Y.

W. L. Brannon, Georgia School of Technology, Atlanta, Ga.

P. M. Clark, Georgia School of Technology, Atlanta, Ga.

A. P. Crisfield, Georgia School of Technology, Atlanta, Ga.

John Dodd, Georgia School of Technology, Atlanta, Ga.

Edward H. Flessa, Iowa State College, Ames, Iowa.

Charles Alfred Freeman, Missouri School of Mines, Rolla, Mo.
W. C. Hansard, Georgia School of Technology, Atlanta, Ga.
William Lloyd Kenagy, Iowa State College, Ames, Iowa.
Kenneth C. Lane, N. Y. School of Clayworking and Ceramics, Alfred, N. Y.
William G. Lewis, Jr., N. Y. School of Clayworking and Ceramics, Alfred, N. Y.
R. G. McKinstry, Georgia School of Technology, Atlanta, Ga.
H. I. Neely, Georgia School of Technology, Atlanta, Ga.
Orland A. Roemer, Iowa State College, Ames, Iowa.
Revere H. Saunders, N. Y. School of Clayworking and Ceramics, Alfred, N. Y.
William Octavius Spencer, University of Illinois, Urbana, Ill.
Paul Melvin Straub, Penn State College, State College, Pa.
Daniel D. Wheeler, Iowa State College, Ames, Iowa.
W. T. Wiggins, Georgia School of Technology, Atlanta, Ga.

Membership Workers' Record

	Corporation		Personal
J. F. Greene	1	H. A. Plusch	1
Edward N. Horr	1	S. R. Scholes	1
Office	1	Henry Weiss	1
	—	Office	7
Total	3		—
		Total	22

	Personal		Student
Charles F. Binns	1		
J. G. Carlisle	1	A. I. Andrews	1
S. S. Cole	1	Paul E. Cox	4
C. M. Dodd	1	C. M. Dodd	1
F. C. Flint	1	A. V. Henry	1
M. M. French	1	J. B. Shaw	1
R. A. Heindl	1	W. H. Vaughn	7
A. C. Held	1	F. Westendick	4
R. D. Humphreys	1		—
W. V. Knowles	1	Total	19
J. M. Manor	1		
D. J. McSwiney	1	Grand Total	44

REPORT OF THE COMMITTEE ON BUDGET FOR 1928

To the President and Board of Trustees (unanimously adopted by the Board)

Your Committee, after studying the accounts for 1927, and estimating the revenue for 1928, has arrived at the following budget, which is submitted for action. The Committee believes that the operating budget should include all major items of expense and has endeavored to provide for them. The total operating budget for 1928 is higher than the budget for 1927 because of the inclusion in the former of certain items which are necessary and which have appeared in the yearly statement for some time but not in the budget report. Our thought is that the officers receiving the financial reports will have a more complete picture of the financial status of the Society if these items are brought to their attention each month.

It is the recommendation of your Committee that:

(1) Where funds are appropriated for special purposes, not covered by the annual budget, these should be carried as separate items on the monthly statement, showing actual expenditures against appropriations.

(2) Where there is income to the SOCIETY to offset special appropriations, this should be shown on the monthly report in addition to that above. (Income from sale of bibliographies would be a case in point.)

Operating Budget Proposed		1928	1927
Rental		$1,080	$900
Refund RCP, extra rent, 7 months at $20		140	
Journal			
Printing		16,000	16,000
Abstracts		1,200	
Editor's Office		1,400	
Soliciting Advertizing		1,800	
Reprints		1,100	1,000
Postage		2,000	2,000
Salaries		12,900	13,500
Secretary	6000		
1st Asst. Editor	2700		
2nd " "	1500		
1st Asst. Sec.	1200		
2nd " "	900		
Extra	600		
Traveling ($300 for European Tour)		1,500	1,200
Office expense		2,200	3,500
Meetings		2,000	1,500
Committees		200	500
Divisions		2,000	2,500
Miscellaneous		200	500
Contingent fund for President		200	200
		$45,920	$43,300

Capital Account	
New Equipment	
Typewriter and table	$200
Depreciation	
Furniture and Fixtures	250
Inventory write-off	650
Unusual Expense	
Glass Bibliography	
Enamel "	

Respectfully submitted,
R. R. Danielson
Geo. W. Denison
J. C. Hostetter

REPORT OF COMMITTEE ON RULES

American Ceramic Society, Feb. 8, 1928

The Committee on Rules calls attention to the fact that the Nominating Committees for the last election of officers were irregular, consisting of more than the prescribed number of members.

The Committee on Rules recommends that as soon as revisions recommended in this report are acted upon the Constitution and By-Laws be printed, either separately or as part of a year book, and distributed to the members of the SOCIETY (see paragraph II, Art. II).

The Committee recommends the following changes in the existing Constitution and By-Laws:

1. That in paragraph (6) Art. II the designation "Perpetual Active Members" be changed to "Life Members" and that in this paragraph the word "perpetually" be stricken out and that there be substituted the words "during the lives of such members."

2. In paragraph (9) Art. II the designation "Perpetual Corporation Members" be changed to "Life Corporation Members" and that in this paragraph the word "perpetually" be deleted and that there be substituted the words "during the existence of such corporations."

3. Paragraph (5) in Art. II be stricken out and the following substituted: "Active Members are Associate Members who have been enrolled twenty-four months. This change in grade occurs automatically."

4. The words "perpetual active" in paragraph (6) Art. II be deleted and the word "life" substituted. Further, that in this paragraph the word "perpetually" be stricken out and the words "during life" substituted.

5. That in paragraph (9) Art. II the word "perpetual" be stricken out and that there be substituted the word "life." Further, that in this paragraph the word "perpetually" be stricken out and replaced by the words "during the existence of such corporation."

6. That in paragraph (11) Art. II the terms "perpetual active members" and "perpetual corporation members" be changed to "life members" and "life corporation members" respectively.

7. In paragraph (12) Art. II the term "perpetual active members" be changed to "life members."

8. In paragraph (3) Art. III the term "perpetual active members" be changed to "life members."

9. In paragraph (5) Art. III the term "perpetual corporation members" be changed to "life corporation members."

10. Paragraph (2) Art V be stricken out and the succeeding paragraphs of this Article be renumbered.

11. In paragraph (3) Art. V the word "Committee" be changed to "Committees."

12. Paragraph (4) Art. V be stricken out and the following substituted "(5) Election of Trustees. Each division, by plurality letter vote of its major members, shall elect a trustee to serve for a period of three years according to the schedule provided in Section X of the By Laws. The names of the Trustees thus chosen by the Divisions shall be certified to the Secretary of the SOCIETY not later than Dec. 31 of each year."

13. Paragraph (5) Art. V be renumbered paragraph (4).

14. In paragraph (1) Art. VI the following be added to the first sentence, "except as otherwise provided."

15. In paragraph (1) Art. VI the following be added to the second sentence, "except as otherwise provided."

16. In paragraph (2) Art. VI the words "five members in addition to" be stricken out.

17. In paragraph (4) Art. VI the words "at least five members in addition to" be stricken out.

18. In paragraph (5) Art. VI the four groups of the Committee on Standards be designated A, B, C, and D.

19. In paragraph (10) Art. VI there be stricken out the words "a chairman and three members appointed by the Board of Trustees."

20. In paragraph (12) Art. VI there be stricken out the words "a chairman appointed by the Board of Trustees and."

21. In paragraph (13) Art. VI there be stricken out the words "a chairman appointed by the Board of Trustees and."

22. A paragraph (3) be added to Art. VII to read as follows: "Representatives of Divisions upon committees of the SOCIETY shall be as indicated in Art. VI."

23. A paragraph (4) be added to Art. VII to read as follows: "Divisions shall have power to make their own rules and By-Laws except that they shall not adopt any rule or By-Laws which conflict with the Constitution and By-Laws of the SOCIETY as a whole."

24. In paragraph (2) of Art. VIII the words "Section I of its rules" be stricken out and that there be substituted the words "Article I of the Constitution."

25. Paragraph (4) Art. X be stricken out and the following substituted: "All papers, discussions and other writings which have been presented before the SOCIETY, its Divisions or Sections, and all committee reports shall become the property of the SOCIETY and their publication or other disposition shall be in the hands of the Committee on Publications.

Any papers, discussions or writings not considered suitable for use in the publications of the SOCIETY by the Committee on Publications must be released or returned to the authors for free use elsewhere and, upon request of authors, decision in this matter must be rendered within sixty days.

No reports prepared by a regularly appointed committee of the SOCIETY or of its Divisions or Sections shall be offered for publication elsewhere until the Committee on Publications shall have been given an opportunity of accepting such reports for publication by the SOCIETY."

26. In Article XII insert the words "and changes" in the headings and in the first line and fifth lines the words "or changes" after the word amendment. In the fifth line strike out the word "was" and insert the word "were." In the seventh line strike out the words "fourteen days" and insert the words "thirty (30) days."

27. In Section I of the By-Laws strike out the words "twenty-five" and insert the word "fifty." Strike out the words "of any regular meeting" and insert the words "at the Annual Meeting."

28. In paragraph (1) Section II add to the tabulation of order of business (3) "Committee Reports" and renumber the tabulation accordingly.

29. In section IV, last line, strike out the words "of active and associate members."

30. Strike out Section VIII and renumber the succeeding sections.

* * * * *

Finally, the Committee on Rules recommends that next year's committee in charge of this work review the work of the Committee on Standards in conjunction with that Committee and simplify the statements in the rules as to scope.

Respectfully submitted,
L. E. Barringer, *Chairman*,
Committee on Rules

REPORT OF THE COMMITTEE ON EDUCATION

Following a suggestion made by last year's Committee, a questionnaire was sent out to the directors of various ceramic schools, the officers of the SOCIETY and its seven divisions, and to the members of the Committee. Seventeen replies were received.

Out of a total of nine school directors replying, three do not recognize any distinction between ceramic engineers and ceramic technologists, although all but one suggested definitions. Out of five officers replying, one does not favor the distinction between the first two classifications and one does not favor any distinction, preferring men trained, for instance, in general chemistry rather than in ceramic chemistry. Of three members of the Committee replying, one of whom is a school director, one does not favor the

distinction between the first two classifications except to limited extent by elective and college curriculum.

(1) Definitions for ceramic engineers, technologists, and artists varied to a large extent, but the following seemed to represent the general consensus of opinion.

(*a*) A ceramic engineer is one who can plan, erect, and operate a plant manufacturing ceramic products.

(*b*) A ceramic technologist is one who can develop new processes and control existing processes in the manufacturing of ceramic products.

(*c*) A ceramic artist is one who can conceive and reproduce ceramic products, pleasing to the eye.

(2) The following is a very brief summary of the suggested differences in the curriculi for the three classifications.

(*a*) Ceramic engineer: Abridged courses in mechanical, electrical, civil, and mining engineering. Limited chemistry and geology. Economics and management. Limited ceramics.

Note: There would be included in the first item, the various subjects generally taught in engineering schools, including drafting and such courses as are considered fundamental to all engineering study.

(*b*) Ceramic technologist: Through chemistry and geology. Laboratory methods and technique. Physics. Ceramics.

(*c*) Ceramic artist: Principle of form and color. Technique or artistic expression by various media. Limited ceramic technology. Laboratory work in ceramic products.

(3) The suggestions with reference to emphasizing products in teaching, may be grouped under three recommendations: (*a*) lectures with exhibits, (*b*) coöperative or "Cincinnati method" of working alternately in school and in practice, (*c*) instructor having and getting as much practice as possible.

(4) Recommendations as to the relative amount of time that should be devoted to matter, men, and money courses, varies to a large extent. Out of seven directors answering this question, the amount of time that should be devoted to matter varies between 85 and 30% for ceramic engineers and 85 to 60% for ceramic technologists. The amount of time to be devoted to men courses: for engineers, 20 to 14%; for technologists, 18 to 10%. For money courses: for engineers, 50 to 5%; for technologists, 30 to 5%. One favored covering men and money by electives and two recommended devoting only enough time to them to awaken interest on the part of the student. The one officer answering this question favors no course for men and money, preferring to rely on outside reading, particularly after graduation. Out of two committee members replying, one is included under directors above and the others favor courses on men and money only in five- or six-year curriculum.

The majority favors giving only enough men and money courses to stimulate students' interest for outside and post-graduate reading, devoting as much time as possible to courses requiring special instruction and special expensive apparatus.

W. KEITH MCAFEE, *Chairman*

BY-LAWS OF THE REFRACTORIES DIVISION

(1) Purposes The objects of this Division shall be the same as those of the AMERICAN CERAMIC SOCIETY with specific reference to refractories.

(2) Membership The membership shall consist of members of the AMERICAN CERAMIC SOCIETY, who have designated their preference in writing to the General Secretary of the SOCIETY to be so registered.

(3) Officers The officers of the Division shall consist of a Chairman, a Vice-chairman, and a Secretary-Treasurer who shall perform the duties ordinarily pertaining to these offices. The officers together with the retiring Chairman and the Chairman of the Program Committee shall constitute an executive Committee which shall manage the affairs of the Division. It shall be the duty of the retiring Secretary-Treasurer to write up the minutes of the Division's business session of the Annual Meeting and submit them to the new Executive Committee within 10 days after said meeting, for their approval. After approval by the Executive-Committee these minutes shall be published promptly in the *Bulletin of the American Ceramic Society*.

(4) Elections (a) Division Officers The officers shall be elected annually by ballot at the last session of the Division held during the Annual Meeting of the SOCIETY. Where a member of the Division cannot attend the Annual Meeting, he may write out his ballot and mail it to the Secretary-Treasurer. All such ballots will be counted as voted at the Annual Meeting. The newly elected officers shall take office at the close of the Meeting at which they are elected and shall hold office for one year, or until their successors are elected. The Chairman shall not be eligible for immediate reëlection. Any vacancies occurring during the year shall be filled by appointment by the Executive Committee. A person so appointed shall not forfeit the privilege of election to the same office to succeed himself.

(b) Nominating Committee At the same session at which the officers of the Division are elected, two members of the Division shall be elected in the same manner as the officers, who shall serve both as the Nominating Committee of the Division and as the Division's Representatives on the General Nominating Committee of the SOCIETY. These two will draw to determine which shall be on Committee No. 1 and which on Committee No. 2. Their names and designations shall be immediately reported to the General Secretary by the Chairman of the Division, or Acting Chairman of the Division. The person drawing No. 1 shall act as Chairman of the Divisional Committee. These two acting as the Divisional Nominating Committee shall report their nominations of the Divisional Officers and nominating committee to the Executive Committee of the Division in time so that the Division Secretary-Treasurer, who is required to do so, can have the nominations announced in the *Bulletin of the American Ceramic Society* or by letter, at least once before the Annual Meeting. Any five members of the Refractories Division may place an additional name or slate of names in nomination by designating such nominations to the Division Chairman in writing, signed by themselves as seconders, at any time before the actual voting for the office designated begins.

(c) Trustee Not later than July 15 preceding the Annual Meeting at which the Trustee from the Refractories Division is to be elected, the Division Secretary-Treasurer shall submit nominating ballots to the members of the Division who shall designate three different names as their preference for this office, and return said ballots to the Division Secretary-Treasurer. In counting these ballots first choice shall count three, second choice two, and third choice one. The name of the person receiving the highest number of counts within thirty (30) days after ballots being sent out shall be certified to the General Secretary of the SOCIETY not later than Dec. 31 of each year, as the trustee representing the Division.

(5) Meetings The Division shall meet in conjunction with the Annual Meeting of the parent SOCIETY and at such other times and places as the Executive Committee acting with the Board of Trustees of the SOCIETY shall decide.

(6) Standing Committees (*a*) The Division Chairman shall appoint chairmen for a Division Program Committee, a Division Membership Committee, and a Division Rules Committee. These chairmen shall in turn select their own committee members.

(*b*) The Division Chairman shall appoint a representative of the Refractories Division to serve on each of the following committees of the AMERICAN CERAMIC SOCIETY:

Committee on Standards, group on Standardization of Tests: one representative.

Committee on Standards, group on Standardization of Products: one representative.

Committee on Research: one representative.

Committee on Data: one representative.

Committee on Ceramic Education: one representative.

Any of these Committees may be dropped and new Committees be added by action of the Executive Committee in accordance with the requirements of the parent SOCIETY.

(7) Special Committees The Chairman of the Division shall appoint such special Committees as the Executive Committee may deem necessary.

(8) Rules on Presentation of Papers So that special programs can be arranged, details concerning the order and time of presentation of papers may be determined by the Executive Committee for any period, prior to the start of that period. However, if the Executive Committee does not pre-arrange such matters, the procedure shall be as follows:

(*a*) The time allowed for the presentation of any paper before any Meeting of this Division shall be limited to 15 minutes unless otherwise ordered by vote of the members present.

(*b*) The time allowed for the discussion of any paper shall be five minutes per speaker; any person, however, speaking on a paper, may speak again after all others desiring to speak on the paper have been heard. If occasion arises the total time of discussion of any paper may be limited by vote of the members present.

(*c*) Papers consisting primarily of promotional or advertising material shall not be presented. The Chairman of the Program Committee shall approve papers. In case of argument resulting from disapproval, or in case of doubt, final decision shall rest with the Executive Committee.

(*d*) The publication rights of all papers and written discussion presented before the Division shall be vested in the AMERICAN CERAMIC SOCIETY unless such rights are specifically released in writing by the Committee on Publications of the parent SOCIETY.

(9) Amending By-Laws These By-laws may be amended in the same manner as the By-laws of the parent SOCIETY are amended.

(10) Quorum Ten members of the Division in good standing at any regularly called meeting shall constitute a quorum. A majority shall rule except as otherwise specified in the By-laws.

NEWS FROM THE LOCAL SECTIONS

Baltimore-Washington Section

Members of the Baltimore-Washington Section met at the Emerson Hotel, Baltimore, Md., January 21, 1928, for the second meeting this season. Twenty-eight members were present.

The following papers were presented: (1) "A Test for Adhesion of Enamels to a Metal Base," by G. T. Thaler of the Bureau of Standards. (2) "Present Status of the Bureau of Standards Investigation of Feldspar," by G. W. Wray of the Bureau of Standards.

The next meeting of the local section is to be held at Washington, D. C., the latter part of March.

Detroit Section

The members of the Detroit Section will hold a meeting on the evening of March 16. "The Age of Speed," a motion picture furnished by Norton Company, will be presented at this meeting. Announcement of the speakers and a list of the members attending will be published in the April *Bulletin*.

Pacific Northwest Section

American Ceramic Society, Clayworkers' Assn., and Brick and Tile Assn.

The annual meeting of the combined Clayworking Associations located in the Pacific Northwest began Friday afternoon, January 20, 1928, at the Seattle Chamber of Commerce under the direction of H. R. Kreitzer, president of the Brick and Tile Assn.

Advertising, promotion, and sales methods for 1928 were outlined. The ceramic department of the University of Washington will make tests on local brick and tile if coöperation can be obtained from a committee to prepare specifications for selection of samples and methods of testing.

Organization of Committees

Committee on Standardization of Products: Hewitt Wilson, Chairman; G. L. Rogers, F. Hidden, F. T. Houlahan.

Oregon Committee on Markets and Advertising: A. H. Wethey, Jr., Chairman; F. Hidden, O. K. Edwards.

Washington Committee on Membership and Advertising: H. O. Thompson, Chairman; Silas Rich, (3rd member to be appointed).

Oregon Committee on Drain Tile Promotion: Philip Corbett, Chairman; J. S. Fisher, G. M. Partridge.

Washington Committee on Drain Tile Promotion: Alex Corbett, Chairman; J. B. Schaeffer, M. D. Saindon, Jr.

Committee on Trade Relations with Mason Contractors and Masons: F. T. Houlahan, Chairman (Note: authorized to call on membership at large to take care of individual situations as they arise); H. R. Kreitzer, Vice Chairman for Oregon.

Membership Committee: Arthur Houlahan, Chairman (Note: authorized to call on membership at large).

Washington Executive Committee: R. R. Smith, F. T. Houlahan, (3rd member to be appointed).

Oregon Executive Committee: H. R. Kreitzer, A. H. Wethey, Jr., F. Hidden.

Auditing Committee: George McFarlane, F. T. Houlahan.

Saturday Meetings, Jan. 21, 1928.

The combined meeting of the ceramists and clayworkers began with an informal, cafeteria luncheon at the University Commons. The new addition to the Mines Building and the new equipment of the ceramic department was inspected in the morning. Then the meeting was called to order by President Mann. The following items of business were transacted:

The secretary reported a membership of 69 individuals and 7 corporations. Twenty-six of these are members in the AMERICAN CERAMIC SOCIETY. During 1927, 16 new members were enrolled, four have withdrawn, and three are deceased. These latter are: John H. Corbett, president Granger Clay Products Co., Yakima, Wash., C. S. Engelbrecht, President, Lake Union Brick and Fireproofing Co., Seattle, Wash., and A. G. Craig, former manager of the Tacoma branch of the Denny Renton Clay and Coal Co.

At the summer meeting held in Portland, July 29, a committee composed of Samuel Geijsbeek, Foster Hidden, and Hewitt Wilson was appointed to work with W. J. Howard in suggesting revisions to the recommended uniform building code being prepared for

the Pacific Coast and to send a representative to Phoenix, Arizona. A revision was made by Howard and O.K.'d by the committee. Five hundred and forty dollars were collected by special subscription from members, Mr. Howard was sent to Phoenix, and a report of his work was sent to the various contributors. The SOCIETY passed a motion to continue this committee during 1928 for the purpose of: (1) purchasing copies of the printed code and distributing them to all the contributors of the special fund (selling price $1.00 each); (2) to purchase one contributing membership and one subscribing membership in the Pacific Code Uniform Building Code Conference for one year, with the money remaining.

A rising vote of thanks in approval of the excellent work done on the Code revision was given to Mr. Howard.

It was moved and passed that a committee be appointed to inquire into the subject of raising the money for the appointment of a ceramic fellowship man to work at the University of Washington on clayworking problems pertinent to ceramic manufacturing of the Pacific Northwest.

The report of the nominating committee was unanimously passed by the SOCIETY. The following are the officers for 1928:

President, W. E. Lemley, Gladding McBean and Co., Taylor, Wash.
Vice-president, Alex Corbett, Granger Clay Products Co., Yakima, Wash.
Secretary, Hewitt Wilson, University of Wash.
Treasurer, H. O. Thompson, Builders' Brick Co., Seattle, Wash.
Ceramic Councillor, Samuel Geijsbeek, Gladding McBean and Co., Seattle, Wash.

The trustees are: for Terra Cotta, A. B. Fosseen, Washington Brick, Lime, and Sewer Pipe Co., Spokane; for Fire Brick, E. E. Saunders, American Fire Brick Co., Spokane; for Pottery, T. S. Mann, Pacific Stoneware Co., Portland; for Brick and Tile, W. J. Howard, Brick and Tile Assn., Seattle.

Report on Publications for 1927

1. "Firing 'Hogged Fuel' in a Continuous Chamber Brick Kiln," by O. K. Edwards, Willamina, Oregon, *Bull. Amer. Ceram. Soc.*, **6** [7], 195–205 (1927).
2. "Clay Washing at Freeman, Wash.," J. M. Hardy, Spokane.
3. "Firebrick Problems," Tom Hall, Moscow, Idaho.
4. "Clay Mining," J. G. Adderson, Renton.
5. "Mining Shale for Sewer Pipe," W. E. Lemley, Taylor, Wash.
6. "Notes on Clay Mining," Joseph Daniels, College of Mines.
7. "Progress Report on the Efflorescence and Scumming of Mortar Materials," Hewitt Wilson, *Jour. Amer. Ceram. Soc.*, **11** [1], 1–31 (1928).
8. "Some Feldspathic Materials of the P. N. W.," Serial No. 2794, Report of Investigation, U. S. Bur. Mines, 1927, Hewitt Wilson.
9. "A Laboratory Apparatus for the Refining of P.N.W. Kaolin," R. J. Clark, *Jour. Amer. Ceram. Soc.*, **10** [2], 98 (1927).
10. "Uranium Oxide Colors and Crystals in Low Temperature Glaze Combinations," James R. Lorah, *Jour. Amer. Ceram. Soc.*, **10** [10], 813 (1927).
11. "Spalling and Loss in Compressive Strength of Fire Brick," H. R. Goodrich, *Jour. Amer. Ceram. Soc.*, **10** [10], 784 (1927).
12. "The Heat-Balance Study of Ceramic Kilns," H. N. Baumann, *Jour. Amer. Ceram. Soc.*, **10** [11], 860 (1927).
13. Ceramic-Clay Technology, Hewitt Wilson, McGraw-Hill Book Co., 1927.

Complete but not published:

14. "Low Temperature Lead Glazes for Puget Sound Red Burning Clays," Hewitt Wilson, Howard Mansur, and Vance Cartwright.

Research Work in Progress

1. The Ochers and Mineral Pigments of the P.N.W., Hewitt Wilson.
2. The Kaolins and Other Whiteware Materials of the P.N.W., Hewitt Wilson.
3. Methods of Dewatering Clay Suspension, Vance Cartwright.
4. The Heat-Balance Study of Ceramic Kilns Part II, Howard Mansur.
5. Colored Vapor Glazes for Face Brick, Howard Mansur.
6. Casting Heavy Sanitary Wares Using P.N.W. Materials, Howard Mansur.
7. Continued Work on the Efflorescence of Brick Mortar Materials, Hewitt Wilson, James Lorah, and Howard Mansur.
8. Testing of Pacific Northwest Clay Products.

New Ceramic Equipment at the University of Washington

1. Hydrogen ion acidity meter. Leeds and Northrup Co. For determining the acidity of glazes and clay slips.
2. Hand roof tile press for interlocking tile. Mueller Machine Co.
3. Auger machine die for Spanish shaped roof tile. Mueller Machine Co.
4. Sanitary molds for tank and lid donated by the Standard Sanitary Ware Co., of San Pablo, Calif.
5. Transverse portable brick testing machine. Morehouse Machine Co.
6. A triple pen, Brown temperature recorder for humidity drier.
7. A four point Brown temperature recorder with six base metal thermocouples for kiln testing.

Treasurer's Report

Pacific Northwest Clayworkers' Association
As of December 31, 1927.

By H. O. Thompson, Treasurer.

Receipts			
Balance on hand, January 1, 1927			$67.25
Memberships		$170.00	
Building code assessments		540.00	710.00
Total receipts			$777.25
Treasury disbursements			
Stationery and stamps	$20.64		
Programs	6.00		
Mimeographing and steno. service	157.40	184.04	
Pacific Coast Building Code Disbursements			
Stationery and clerical expense	67.50		
Traveling expense (Phoenix)	297.08	364.58	548.62
Treasury balance		53.21	
Building Code balance		175.42	$228.63
Balance per bank statement Dec. 31, 1927			228.63

Papers Presented

The following papers were read and discussed.

1. "Fire Brick Tests at Renton," G. L. Rogers, Ceramic Engineer, Gladding McBean Co., Seattle.
2. "Recent Developments in Fire Brick Testing," E. E. Saunders, American Fire Brick Co., Spokane.
3. "Northwest Products," K. E. Leib, College of Business Administration, University of Washington.

4. "The Development of Faience Tile at Clayton," Edward Burkhalter, Washington Brick, Lime, and Sewer Pipe Company, Spokane.

5. Reports from the Ceramic Engineering Dept., University of Washington. "Kiln Testing," Howard Mansur. "Spray Evaporator," Vance Cartwright.

6. "Comparison of the Activities of the P.N.W. Associations with those of the Ohio Ceramics Industries Association," Hewitt Wilson.

A banquet was held Saturday evening at the Engineer's Club. A number of one-minute speakers were introduced by Raymond R. Smith, the toastmaster, and E. E. Saunders and E. F. Goodner contributed to the fun of the evening with chemical and electrical displays. The address of the evening was delivered by Edwin J. Ivey, on, "The Architectural Use of Clay Products in Europe." Mr. Ivey is a well-known Seattle architect who recently spent some time in Europe and his lecture was accompanied by many colored illustrations of mosaic tile interiors and exteriors to show the use of clay products.

A partial list of the attendance follows:

E. F. Goodner, Corwin D. Smith Co., Seattle
Hewitt Wilson, University of Washington
E. E. Saunders, America Fire Brick Co., Spokane
T. S. Mann, Pacific Stoneware Co., Portland
V. L. Nielsen, Gladding McBean and Co., Seattle
A. N. Johnson " " " " "
N. W. L. Brown " " " " "
Gregory L. Rogers " " " " "
Raymond R. Smith " " " " "
David D. Hood " " " " Portland
J. P. Fulcher, " " " " Tacoma
Paul S. MacMichael " " " " Seattle
E. K. McQuarrie, " " " " "
Frank O. Carson " " " " "
J. B. DeGolyer " " " " "
D. J. Brown " " " " "
T. E. Nicholson " " " " "
S. Geijsbeek " " " " "
W. E. Lemley " " " " Taylor
Silas Rich " " " " Seattle
J. M. Harby, Seattle
Foster Hidden, Hidden Bros. Brick and Tile Co., Vancouver, B. C.
Kenneth A. Johnson, U. S. Bureau of Mines, Seattle
Arthur Houlahan, Builders' Brick Co., Seattle
Frank Houlahan " " " "
H. O. Thompson " " " "
Geo. Kribs " " " "
J. O. Hankins, Seattle Pottery, Seattle
H. S. Magid, Kokomo, Ind.
H. B. McMillen, Seattle
J. F. Hobson, Wenatchee Brick and Tile Co., Wenatchee, Wash.
H. O. Wilson, Seattle
Milnor Roberts, College of Mines, University of Wash.
Joseph Daniels, " " " " " "
W. J. Howard, Pac. N. W. Brick and Tile Assn., Seattle
G. B. Richardson, Ceramic Dept., University of Wash.
Howard Mansur, " " " " "
Vance Cartwright " " " " "
E. S. Edwards, Willamina Clay Products Co., Willamina, Ore.
O. K. Edwards, " " " " " "
N. H. Nelson, Pacific Coast Co., Seattle
C. M. Jenkins, E. J. Bartells Co., Seattle
E. W. Dow, San Francisco, Calif.
George R. Stirrat, Seattle Brick and Tile Co., Seattle
John B. Stirrat " " " " " "

H. Hoffmann, Lake Union Brick and Fireproofing Co., Seattle
Alex Corbett, Granger Clay Products Co., Yakima, Wash.
K. E. Leib, University of Washington.
G. S. Eldridge, B. C. Testing Laboratory, Vancouver, B. C.
Albert Armstrong, Interlocking Tile Corp., Seattle.
H. K. Benson, University of Wash.
J. B. Shaffer, Everett Brick Co., Everett, Wash.
H. R. Kreitzer, Columbia Brick Co., Portland.

Hewitt Wilson, Secretary.

NOTES FROM THE CERAMIC SCHOOLS

New York School of Clayworking and Ceramics

William G. Collins, president of the Student Branch of the AMERICAN CERAMIC SOCIETY has sent the following letter to the Secretary's office, which typifies the enthusiasm of the ceramic students of that School.

Alfred, N. J.
January, 15, 1928.

Dear Sir:

Feeling that little information of the ceramic schools of the country is printed I am inclosing the following news items on recent happenings at the New York School of Clayworking and Ceramics.

Alfred University has met the demand of its increased registration in the New York School of Clayworking and Ceramics by expanding into another building on the campus. More than sixty freshmen were registered in this course last fall, showing an increasing demand for ceramics in Alfred. Additional appropriations from the State Department of Education, which controls the School made possible the additional floor space for the ceramic engineers.

The first major change was the transferring of the Department of Applied Art to the Agricultural School building. Thus the entire Ceramic School building was turned over to the Engineering Department. The Ceramic Engineering Chemistry courses were transferred from the Allen Memorial Hall to the Ceramic building where complete laboratories were constructed on the second floor. The separation of the Ceramic Chemistry from the College Chemistry makes it easier to put more stress on the chemistry of ceramics.

More impetus was given Ceramic Engineering recently by the formation of the Delta Pi Alpha local ceramic fraternity, for the promotion of scholarship, craftsmanship, and ability in ceramics. The project is indorsed by Charles F. Binns, Director of the School, whose ability as a teacher and advisor in this recent expansion has been a credit.

The following news item from our college paper contains some information as to a recent bill being brought before the New York State Legislature.

WILLIAM G. COLLINS, *President*

For New Addition to Ceramic School

A quest for a new $125,000 building for the Ceramic School occasioned President Boothe C. Davis' visit to Albany for several days last week. A bill will be introduced in the present session of the legislature asking for the appropriation of $125,000 from New York State's new $100,000,000 bond issue.

The present step is but a renewed attack for an issue which has been before the Legislature periodically since 1921. In that year, application was made for a $65,000 addition to the Ceramic Building. In 1925 the request was granted by the legislature, but was vetoed by Governor Alfred E. Smith on the ground that the improvement should be paid for from the $100,000,000 bond issue which had not yet been approved by the voters of New York state.

Although the application was reiterated in 1925 and 1926, the Ceramic School still lacks the desired assistance.

Last year, when the Ceramic School was 60% larger than in 1921, and the Agricultural School seemed on the decline, the Legislature granted the Ceramic School the use

of laboratory space in the Agricultural Buildings. While, at present, the Ceramic School has more adequate quarters than those of last year, the Agricultural School, which has grown 40% during the past year, is at a disadvantage because of lack of space.

During the six years consumed by the legislature in the consideration of the $65,000 project, there has been such growth in the Ceramic and Agricultural Schools that neither the old project nor the current temporary arrangement is adequate to cope with present and future needs.

Hence, the college authorities have decided to apply for a new building, to be erected at an estimated cost of $125,000; the amount to be drawn from the new $100,000,000 bond issue.

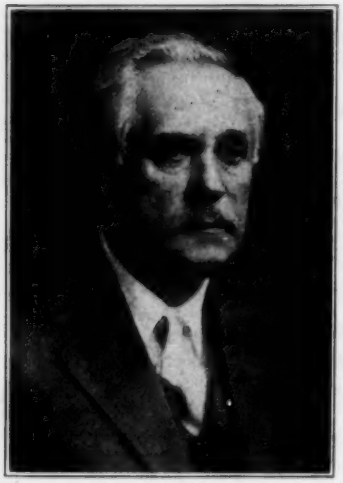
NOTES AND NEWS

INDUSTRIAL ART SCHOOL IN CHICAGO

Contribution from Gustav Hottinger

The recent announcement made by the Association of Arts and Industries of the $50,000 contribution of Gustav Hottinger, President of The Northwestern Terra Cotta Company, to the fund for establishing an Industrial Art School was greeted with enthusiasm by the public spirited citizens of the Middle West. Mr. Hottinger's generous donation completed the quota of $260,000 set by the Rockefeller Foundation as the condition for an additional gift of $100,000.

The Industrial Art School to be housed in the Art Institute of Chicago is now assured. It will offer the finest instruction in all industrial arts including architectural modeling, jewelry, printing, wall paper, textiles, ceramics, interior decorating, and costume designing. "The Hottinger Foundation of Architectural Modeling, Founded by Gustav Hottinger, 1928" will take care of that department.



GUSTAV HOTTINGER

Mr. Hottinger's gift was not primarily for the purpose of establishing a fitting memorial for his name but of giving ambitious young men an opportunity to train themselves properly for better service in the industrial field. Now the president of of the largest terra cotta company in the United States, Mr. Hottinger began as a clay modeler with only his ambition and natural talents to aid him. He realizes perhaps more than others the potentialities for good the new school possesses.

This is not his first act of outstanding philanthropy. Several years ago he gained nation-wide attention by his gift of a $4,000,000 share in The Northwestern Terra Cotta Company to the thirty-six men who had helped him build up his great business.

Mr. Hottinger has supported the AMERICAN CERAMIC SOCIETY from the time of its inception, has recognized the value of employing scientists and engineers especially trained in ceramics, and he has been in the lead in the employment of artists to create and extend the use of terra cotta. The terra cotta industry is greatly indebted to Mr. Hottinger but no more so than all the varied ceramic industries. The founding of an Industrial Art School is only another of Mr. Hottinger's contributions to industrial ceramics.

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION MEETING IN JUNE

Gordon C. Keith, Secretary of the Canadian National Clay Products Association, has issued an urgent invitation to the members of the AMERICAN CERAMIC SOCIETY to join with the Canadians during the Annual Meeting at the Windsor Hotel, Montreal, June 11, 12, and 13, 1928.

The members of the Montreal Committee are particularly desirous of having a large number of SOCIETY members visit their city. In addition to the technical sessions there will be many social features and trips. These include:

Trips to some of the finest brick plants on the Continent, located near Montreal. Trips to pottery and sewer pipe plants. Trips to places of interest for which the Province of Quebec is noted.

A special three-day program for the ladies during the whole three days of the convention is planned.

A steamer has been chartered to make a delightful trip following the convention, down the St. Lawrence past the historical city of Quebec to the Sagineau River, then up the river to the hinterland of Quebec where giant paper mills and aluminum works and power plants are located. The boat will leave Montreal Wednesday night and return Saturday morning. In June this trip is a delightful and rare treat. The cost of the trip will be less than the ordinary tourist rate.

STANDARD SAMPLES ISSUED BY THE U. S. BUREAU OF STANDARDS

The U. S. Bureau of Standards is now prepared to furnish the standard samples listed below. Attention is particularly called to the new standard samples of acid potassium phthalate, arsenious oxide, dolomite, glass sand, lead-barium glass and ferrotungsten.

Sample number	Name	Constituents determined or intended use	Weight of sample in grains	Fee per sample
88	Dolomite	Complete analysis	50	$2.00
70	Feldspar	do	40	2.00
80	Glass, soda-lime	do	45	2.00
89	Lead barium glass	do	45	2.00
76	Burnt refractory (40% Al_2O_3)	do	60	2.00
77	Burnt refractory (60% Al_2O_3)	do	60	2.00
78	Burnt refractory (70% Al_2O_3)	do	60	2.00
81	Glass sand FeO_3, Al_2O_3, TiO_2, ZrO_2, CaO, MgO		60	2.00
2	Zinc ore D	Zinc	50	1.00
25b	Manganese ore	Manganese, available oxygen	100	2.00
26	Crescent iron ore	Al_2O_3, CaO, MgO	100	2.00
27a	Sibley iron ore	SiO_2, P, Fe	125	2.00
28	Norrie iron ore	Mn (low)	50	1.00
29	Magnetite iron ore (titaniferous)	Complete analysis	50	1.00
56	Phosphate rock	P_2O_5, Fe_2O_3, Al_2O_3, etc.	60	2.00
69	Bauxite	Complete analysis	60	2.00
71	Calcium molybdate	Mo, Fe, Ti	60	2.50
4c	Cast iron	C, Mn, P, S, Si, Ti, (Cu, Ni, Cr, V)	150	2.50
5e	Cast iron	C, Mn, P, S, Si, Ti, (Cu, Ni, Cr, V)	150	2.50
6d	Cast iron	C, Mn, P, S, Si, Ti, (Cu, Ni, Cr, V)	150	2.50
7b	Cast iron	C, Mn, P, S, Si, Ti, (Cu, Ni, Cr, V)	150	2.50
55	Ingot iron	C, Mn, P, S, Si, Cu, Ni	150	2.00
74	Cast iron	C, Mn, P, S, Si, Ti, (Cu, Ni, Cr, V)	150	2.50
82	Nickel-chromium cast iron	C, Mn, P, S, Si, Cr, Ni (Ti, Cu, V)	150	2.50
8c	Steel, Bessemer, 0.1 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V)	150	2.00
9c	Steel, Bessemer, 0.2 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V)	150	2.00

Sample number	Name	Constituents determined or intended use	Weight of sample in grains	Fee per sample
10d	Steel, Bessemer, 0.4 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V)	150	2.00
22b	Steel, Bessemer, 0.6 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V)	150	2.00
23a	Steel, Bessemer, 0.8 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V)	150	2.00
15b	Steel, B. O. H., 0.1 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V, As)	150	2.00
11c	Steel, B. O. H., 0.2 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V, As)	150	2.00
12c	Steel, B. O. H., 0.4 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V, As)	150	2.00
13c	Steel, B. O. H., 0.6 C	C, Mn, P, S, Si, (Cu, Ni, Cr)	150	2.00
14b	Steel, B. O. H., 0.8 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V)	150	2.00
16b	Steel, B. O. H., 1.0 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V, As)	150	2.00
19b	Steel, A. O. H., 0.2 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V)	150	2.00
20c	Steel, A. O. H., 0.4 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V)	150	2.00
21b	Steel, A. O. H., 0.6 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V)	150	2.00
34	Steel, A. O. H., 0.8 C	C, Mn, P, S, Si, (Cu, Cr, Mo)	150	2.00
35a	Steel, A. O. H., 1.0 C	C, Mn, P, S, Si, (Cu, Cr)	150	2.00
51	Steel, electric furnace, 1.2 C	C, Mn, P, S, Si, (Cu, Ni, Cr, V)	150	2.00
65	Steel, acid electric	C, Mn, P, S, Si, (Cu, Ni, Cr, V)	150	2.00
30b	Steel, chrome-vanadium	C, Mn, P, S, Si, Cr, V, (Cu, Ni)	150	3.00
32b	Steel, chrome-nickel	C, Mn, P, S, Si, Cr, Ni, (Cu)	150	3.00
33a	Steel, nickel	C, Mn, P, S, Si, Ni, (Cu, Cr, V)	150	3.00
50	Steel, chrome-tungsten-vanadium	C, Mn, P, S, Si, W, Cr, V, (Cu, Mo)	150	3.50
72	Steel, chrome-molybdenum	C, Mn, P, S, Si, Cr, Mo, (Cu, V)	150	3.00
73	Steel, stainless	C, Mn, P, S, Si, Cr, (Cu, V, Mo)	150	3.00
57	Refined silicon	Complete analysis	60	2.00
58	Ferrosilicon (75 % silicon)	do	75	2.00
59	Ferrosilicon (50 % silicon)	do	75	2.00
61	Ferrovanadium (high carbon)	do	100	3.00
64	Ferrochromium (high carbon)	do	100	3.00
66	Spiegeleisen	do	100	2.00
67	Manganese metal	do	100	2.50
68	Ferromanganese	do	100	2.50
75	Ferrotungsten	W, C, M, P, S, Si, Sn, As, Mo, Cu, Sb	150	4.00
37b	Brass, sheet	do	150	3.00
52	Bronze, cast	do	150	3.00
53	Lead-base bearing metal	do	200	3.00
54	Tin-base bearing metal	do	200	3.00
62	Manganese bronze	do	150	3.00
63	Phosphor-bronze bearing metal	do	150	3.00
42b	Tin	Melting point 231.9°C	350	2.00
43b	Zinc	Melting point 419.4°C	350	2.00
44b	Aluminum	Melting point 658.9°C	200	1.00
45a	Copper	Melting point 1,083°C	450	2.00
49	Lead	Melting point 327.3°C	1,650	2.00
46m	Cement (normal)	Fineness (testing sieves)	160	1.00
47d	Cement (extra fine)	do	160	1.00
84	Acid potassium phthalate	Acidimetric value	60	3.00
39c	Benzoic acid	Acidimetric and calorimetric values	30	2.00
40b	Sodium oxalate	Oxidimetric value	60	2.00
83	Arsenious oxide	do	75	2.00
38a	Naphthalene	Calorimetric value	50	2.00
17	Sucrose	Calorimetric and saccharimetric values	60	2.00
41	Dextrose	Reducing value	70	2.00

Information as to the history of the standard samples, their use in checking methods of analyses, standardizing solutions, calibrating pyrometers, etc., are given in Bureau

of Standards Circular, No. 25. Summaries of analyses of the standard samples and general information are given in the Supplement to Circular, No. 25. These can be obtained free of charge upon application to the Bureau of Standards, Washington, D. C. Detailed certificates of analyses are sent under separate cover to the same destination as the samples.

Ordering Orders should give both the number and name of the sample wanted. Example: No. 9c, steel, Bessemer, 0.2C. No samples of smaller size than those listed are distributed.

Terms and Shipping (*a*) Domestic: Samples may be paid for in advance with order. If the remittance does not accompany the order, all samples will be sent under Government frank by parcel post C.O.D. in the United States and its possessions. It is therefore important that firms with branch laboratories send remittance with the order if the laboratories can not receive C.O.D. packages. Both the central office and branch laboratory will be notified when shipment is made. No discounts are allowed on any orders.

(*b*) Foreign: All foreign shipments require prepayment. With the exception of Mexico and Canada, 20 cents postage must be added for every 300 grams of sample. Shipments intended for Mexico and Canada will be sent under Government frank, but not C.O.D.

(*c*) Money Orders, etc., should be payable to the Bureau of Standards.

RESEARCH GRADUATE ASSISTANTSHIPS

Engineering Experiment Station, University of Illinois

To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen Research Graduate Assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry.

An appointment to the position of Research Graduate Assistant is made and must be accepted for two consecutive collegiate years of ten months each, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. Half of the time of a Research Graduate Assistant (approximately 900 clock hours for each ten-month period) is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study.

Nominations to these positions, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the Director of the Station each year not later than the first day of April. The nominations are made by the Executive Staff of the Station subject to approval of the President of the University. Nominations are based upon the character, scholastic attainments, and promise of success in the principal line of study or research to which the candidate proposes to devote himself. Preference is given those applicants who have had some practical engineering experience following the completion of the undergraduate work. Appointments are made in the spring, and they become effective the first day of the following September. Vacancies may be filled by similar nominations and appointments at other times.

Additional information may be obtained by addressing The Director, Engineering Experiment Station, University of Illinois, Urbana, Illinois.

SOCIETY OF GLASS TECHNOLOGY

Meetings of the Society of Glass Technology were held at Stourbridge, November 22, 1927, University College, London, on December 14, 1927, and at the College of Technology, Manchester.

At the Stourbridge meeting the following papers were presented: "Modern Artistic Glass," by W. E. S. Turner; "Stourbridge Fire Clays and the Manufacture of Glass House Pots," by M. H. Edwards; and "Glass Pot Manufacture in Great Britain," by W. E. S. Turner.

At the London Meeting papers were presented by J. H. Davidson on "The Analysis of Opal Glasses;" S. English, H. W. Howes, and W. E. S. Turner on "The Effect of Iron Oxide on the Properties of Glass;" and V. Dimbleby and W. E. S. Turner on "The Durability of Iron-Containing Glasses."

At the Manchester meeting discussions on the following subjects were presented: The Design and Operation of Glass Furnaces," discussed by W. W. Warren; "The Refining of Glass," discussed by W. E. S. Turner and H. Hemingway; and "The Manufacture and Use of Glasshouse Pots" by P. Marson.

CALENDAR OF CONVENTIONS

AMERICAN CERAMIC SOCIETY		
Annual Meeting	Feb. 1929	Chicago, Ill.
Ceramists' Tour Abroad	May 19–July 5, 1928	
Amer. Chemical Society	April 16–20, 1928	St. Louis, Mo.
American Electrochemical Society		
(Spring Meeting)	April 26–28, 1928	Bridgeport, Conn.
(Fall Meeting)	Sept. 20–22, 1928	Charleston, W. Va.
Amer. Foundrymen's Assn.	May 14–18, 1928	Philadelphia, Pa.
Amer. Gas Assn. (Natural Gas Dept.)	May, 1928	Dallas, Texas
Amer. Institute of Architects	May 9–11, 1928	St. Louis, Mo.
Amer. Soc. Mechanical Engineers		
(50th Anniversary)	April 7, 1928	Washington, D. C.
(Spring Meeting)	May 14–17, 1928	Pittsburgh, Pa.
(Regional)	Aug. 27–29, 1928	St. Paul-Minneapolis
(Regional)	Oct. 1–3, 1928	Boston, Mass.
Amer. Soc. Steel Treating		
(Annual Meeting)	Oct. 8–13, 1928	Philadelphia, Pa.
Amer. Zinc Institute	April 16–18, 1928	St. Louis, Mo.
Assn. of Sci. App. Makers of Amer.	May 5–7, 1928	Atlantic City, N. J.
Canadian Natl. Clay Products Assn.	June 11–13	Montreal, Quebec
Joseph A. Holmes Safety Assn., Inc.	March 5	Washington, D. C.
Mfg. Chemists Assn. of U. S.	June 2, 1928	New York City
Natl. Acad. of Sciences	April 23–25, 1928	Washington, D. C.
Natl. Assn. of Mfgrs.	Oct., 1928	
Natl. Assn. Mfgrs. Heating and Cooking Appliances	May 9–10, 1928	Detroit, Mich.
Natl. Clay Prod. Ind. Assn.	April, 1928	Chicago, Ill.
Optical Soc. of Amer.	October, 1928	Washington, D. C.
Safety Congress	Oct. 1–5, 1928	New York City

U. S. Rotary Enamel Smelting Furnaces Give

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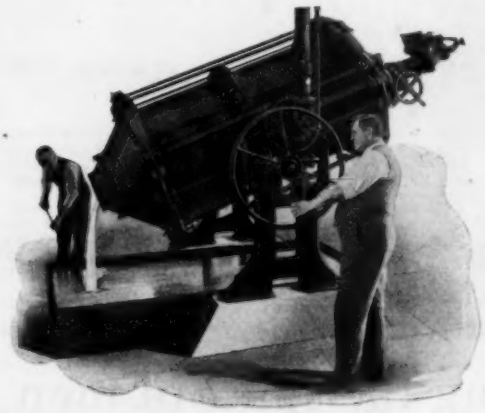

Excellent Results Best Demonstrated by Large Number of Repeat Orders

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Porcelain Enamel & Mfg. Company, Baltimore, Md.
Ingram-Richardson Mfg. Company, Frankfort, Ind.
Ingram-Richardson Mfg. Company, Beaver Falls, Pa.
Ingram-Richardson Corporation, Bayonne, N. J.
Grand Rapids Refrigerator Co., Grand Rapids, Mich.
Columbian Enameling & Stamping Co., Terre Haute, Ind.
Sheet Metal Products Company, Toronto, Canada.
Republic Metalware Company, Buffalo, N. Y.
Pacific Sanitary Mfg. Company, Richmond, California.
A. Weiskittel & Son Company, Baltimore, Md.
Malleable Iron Range Company, Beaver Dam, Wis.
Edison Electric Appliance Co., Inc., Chicago, Ill.
Welsh Tinplate & Metal Stpg. Co., Ltd., Llanelly, England.
Ernest Stevens, Limited, Cradley Heath, England.
Ward Leonard Electric Company, Mount Vernon, N. Y.
American Enameled Products Co., Chicago, Ill.
Michigan Porcelain Tile Works, Ionia, Michigan.
Stanley Insulating Company, Great Barrington, Mass.
Roesch Enamel Range Company, Belleville, Ill.
L. D. Caulk Company, Milford, Delaware.

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No. 1	No. 2	No. 3	No. 4	No. 4-B
60 lb.	150 lb.	350 lb.	750 lb.	1200 lb.

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THE U. S. SMELTING FURNACE CO.

BELLEVILLE, ILLINOIS, U. S. A.

Incidents That Have Pointed the Way—No. 3 of a Series.

It was a hotly contested game. The sheet mill team won. The electrical team, which had so generously permitted the use of a borrowed catcher, went down to defeat.

Crystallizing the spirit of men

BASEBALL was in the air; the championship of Armco would be decided between the sheet mill and the electrical departments. All season long eight different departmental teams had been waging the struggle toward the final victory.

A few days before the final contest, the catcher on the sheet mill team was incapacitated. "We're done for; no use playing now," said the captain in despair.

But Lonnie, captain of the electrical team, thought differently. "Here, take your pick of any of the catchers of the other teams," he said. "We want to win on the square or not at all."

It was a hotly contested game. The sheet mill won. The electrical team, which had so generously permitted the use of a borrowed catcher, went down to defeat.

But so impressed was the Company with the good will and fellowship of the incident that a medal typifying the Armco Spirit which had been crystallized by the incident was struck off and presented to the losing team at the same time that the cup was presented to the winners. In making this presentation, the president of the company defined that Spirit as follows:

The ARMCO Spirit

Armco Spirit is a comprehensive, vital force which finds expression in the practical application of policies builded on a platform of Christian principles, in which selfish purpose has no place.

Armco Spirit combines, in proportion, a spirit of fairness; a square deal always, both in theory and practice; a big, broad view of every problem, cutting out all narrowness and littleness; a spirit of unselfishness, of loyalty, of courtesy to and consideration for the other fellow.

Armco Spirit is, in fact, simply an exemplification of the highest standard of real American citizenship.

Spirit is that thing which grips and holds the hearts of men, and gives them the power of extraordinary accomplishment when working for a worthy purpose.

Such has been the influence behind the men who are devoting their best thought and energy to the making of ARMCO Ingot Iron—a durable, long-lasting iron.

Ideal for Vitreous Enameling

Enamelers everywhere find in ARMCO Ingot Iron the solution to many vexatious problems. Being pure, uniform and virtually degasified, it reduces cull losses, thereby increasing plant profits. Moreover, ARMCO Ingot Iron has a velvety-textured surface which grips and holds enamel. From the ground coat to the finished job it consistently produces *results*

ARMCO Ingot Iron

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BUYERS' GUIDE

A

Air Reducing Valves
Fisher Governor Co.

Air Traps
Fisher Governor Co.

Alumina (Hydrate and Calcined)
Harshaw, Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

Aluminum Oxide (fused)
The Exolon Co.

Aloxite (Refractory Products)
The Carborundum Co.

Alundum (Refractory Products)
Norton Co.

Antimony Oxide
Jungmann & Co.
Roessler & Hasslacher Chemical Co.

Ammonium Bi-fluoride
Ammonium Carbonate
Jungmann & Co., Inc.

Auger Machines
Chambers Brothers Co.

Automatic Control Valves
Maxon Premix Burner Co.

Automatic Cutters
Chambers Brothers Co.

Automatic Stove Rooms
Philadelphia Drying Machinery Co.

Automatic Temperature Control
Brown Instrument Co.
Leeds & Northrup Co.

B

Back Pressure Valves
Fisher Governor Co.

Ball Mills (Laboratory Type)
Fisher Scientific Co.

Ball Mills
McDaniel Refrac. Porcelain Co.
Mueller Machine Co., Inc.

Barium Carbonate
Roessler & Hasslacher Chemical Co.

Barium Hydrate
Jungmann & Co., Inc.

Barytes

Batts
The Carborundum Co. *("Carbofrax Aloxite")*
Norton Co. *("Alundum-Crystolon")*

Bitstone
Potters Supply Co.

Blocks (Refractory)
The Carborundum Co.
Norton Co.

Blowers
Jeffrey Mfg. Co.

Blowers (centrifugal—high pressure)
Maxon Premix Burner Co. *(Premix)*

Boats, Combustion
Fisher Scientific Co.
Norton Co.

Boiler Feeders
Fisher Governor Co.

Borax
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Innis, Speiden & Co.
Pacific Coast Borax Co.
Roessler & Hasslacher Chemical Co.

Boric Acid (Anhydrous)
Pacific Coast Borax Co.

For Tunnel Kilns—
Alundum Muffle Chambers

Refractories used for making up firing chambers of tunnel kilns must be chosen with respect to their ability to maintain their shape and refractoriness during long periods of continuous operation.

Alundum (fused alumina) Refractories possess these necessary qualities and therefore are particularly well suited for use in Dressler tunnel kilns. In the installation pictured the kiln has been continuously operated since March, 1925.

NORTON COMPANY
WORCESTER, MASS.

New York Chicago
Cleveland

R-323

Alundum Refractories

Stand high temperatures without deformation.

Are free from danger of oxidation.

Fused alumina (Alundum) is thoroughly preshrunk in process of manufacture of raw material.

NORTON
REFRACTORIES

BUYERS' GUIDE (continued)

Boric Acid (Crystal, Granular or Powder)
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Innis Speiden & Co.
Pacific Coast Borax Co.

Borax Glass
Pacific Coast Borax Co.

Brick Making Machinery
Chambers Brothers Co.

Bricks (Refractory)
The Carborundum Co. *("Carbofrax Aloxite")*
Harbison Walker Refractories Co.
Norton Co. *("Alundum-Crystolon")*

Bucket Elevators
Jeffrey Mfg. Co.

Burners (Gas—Oil)
Maxon Premix Burner Co.

Burners (Combination Oil and Gas)
Maxon Premix Burner Co.

C

Carbofrax (Refractory Products)
The Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

Carbonates (Barium-Lead)
Innis, Speiden & Co.
Roessler & Hasslacher Chemical Co.

Caustic Soda
Pennsylvania Salt Mfg. Co.

Cements
The Carborundum Co.
Harbison Walker Refractories Co.
Massillon Stone & Fire Brick Co.
Norton Co.

Ceramic Chemicals
Drakenfeld and Co., B. F.
Harshaw, Fuller & Goodwin Co.
Jungmann & Co., Inc.
Metal & Thermit Corp.
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.
Harbison Walker Refractories Co.

Ceramic Plant Equipment
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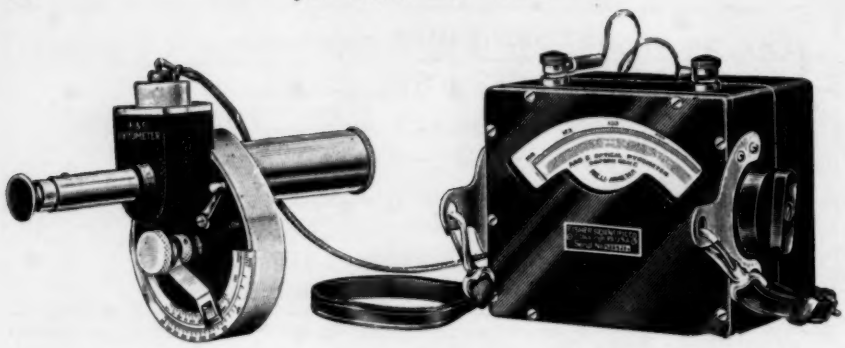

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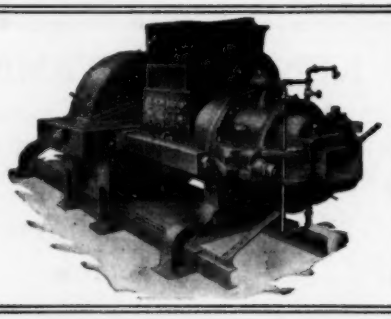

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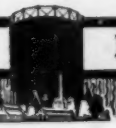

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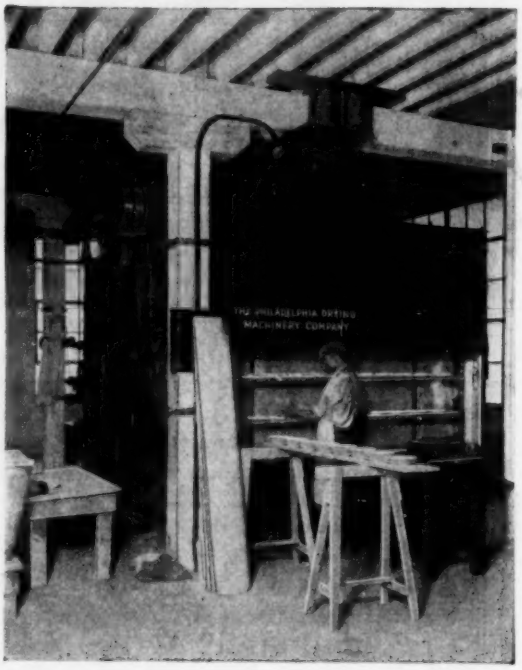

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